Municipal Engineering

Design, Construction, Operation and Maintenance of All Public Works

Vol. LIV. JUNE, 1918. No. 6.

CONTENTS.

Editorials 221

Fundamental Changes Favorable to Construction—Standard Construction Methods—Stress the Word Engineering.

Pavement Design and Construction.....223

Asphaltic and Non-Asphaltic Road-Oil Specifications—Data on California Asphalt Paving Work Performed with Portable Asphalt Plant—An Argument for Changing Common Method of Financing Pavement Construction and Renewals—Methods and Cost of Building Gravel Roads in Kane County, Illinois—Use of Road Tar Growing.

Sewer Design and Construction.....228

Organization of Forces and Plant and Methods Employed in Construction of Sewers in Chicago—Facilitating the Construction of Water and Sewerage Works by Means of the Cement-Gun.

Water Works Design and Construction.....237

The New Mayfair Pumping Station of the Chicago Water Works—Present High Prices on Water Works Materials Will Continue after the War—Some Design Features of the Waban Hill Covered Reservoir of the Newton, Mass., Water Works—Methods Employed in Reconstructing Fort Madison, Ia., Water Works Plant on Exact Site of Old Plant without Interrupting Operation—Use of Condensing Apparatus in Water Works Plants.

Water Purification and Sewage Treatment...244

The Development of Sewage Treatment—Some Results Secured by Chlorine Compounds in Water Purification and Sewage Treatment.

From Workers in Field and Office.....252

Anonymous Communications—Using Compressed Air Equipment on Street Repairs—The Cost of Drilling Blast Holes—Ohio Highway Department Employs Compressed Air Equipment in Repair of Brick and Concrete Roads—The Bankhead National Highway—Making Tight Joints in Vitrified Clay Sewer Lines.

Plant Units and Layouts.....254

New Concrete Mixer Loader a Big Cost Cutter—Some Hints on Economical and Ornamental Street Lighting.

General Articles 256

Some Observations on a Common Practice in Sidewalk Construction—City Planning as an Engineering Problem—Methods Employed and Precautions Observed in Blasting in City Streets—How Engineering Records of Underground Structures Are Kept in Baltimore.

MUNICIPAL ENGINEERING is published monthly by Engineering Publishing Company, 702 Wulsin Building, INDIANAPOLIS, INDIANA, A. P. Fox, President; J. H. Pritchard, Secretary.

The Editorial and Advertising Offices are at 538 S. Clark St., CHICAGO, ILLINOIS. Samuel C. Hadden, Editor. Louis McLouth, Advertising Manager. A. L. Marsh, Eastern Manager, 30 Church St., New York.

Single copies, 25 cents. The yearly subscription price in the United States and its Possessions, Cuba and Mexico, is $2.00; in aCnada, $2.40; and in all other countries, $2.75.

Entered at the Post-Office, Indianapolis, Indiana, as Second-Class Matter.

Changes of address, subscriptions and remittances should be addressed to MUNICIPAL ENGINEERING, Indianapolis, Indiana. Editorial and business communications should be addressed to 538 S. Clark St., Chicago, Illinois.

Austin=Western Road= Making Machinery

includes a complete line for grading, rock crushing and surfacing. Prominent Cities and Park Boards throughout the country use and appreciate the utility and economy of operation in every

AUSTIN-WESTERN MACHINE

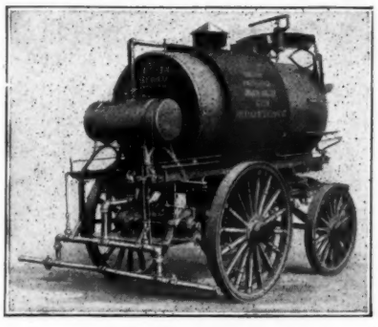
Austin Two-Speed Sprinkler-Sweeper

cleans asphalt and brick streets with maximum efficiency. Practically all dust eliminated by the water spray. The two-speed broom is another very desirable feature. Write for special catalog.

Austin Two-Speed Sprinkler-Sweeper

Austin Road Oilers

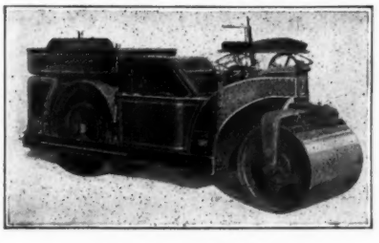
make earth, gravel and macadam roads like asphalt.



Austin Road Oiler.

Austin Road Rollers

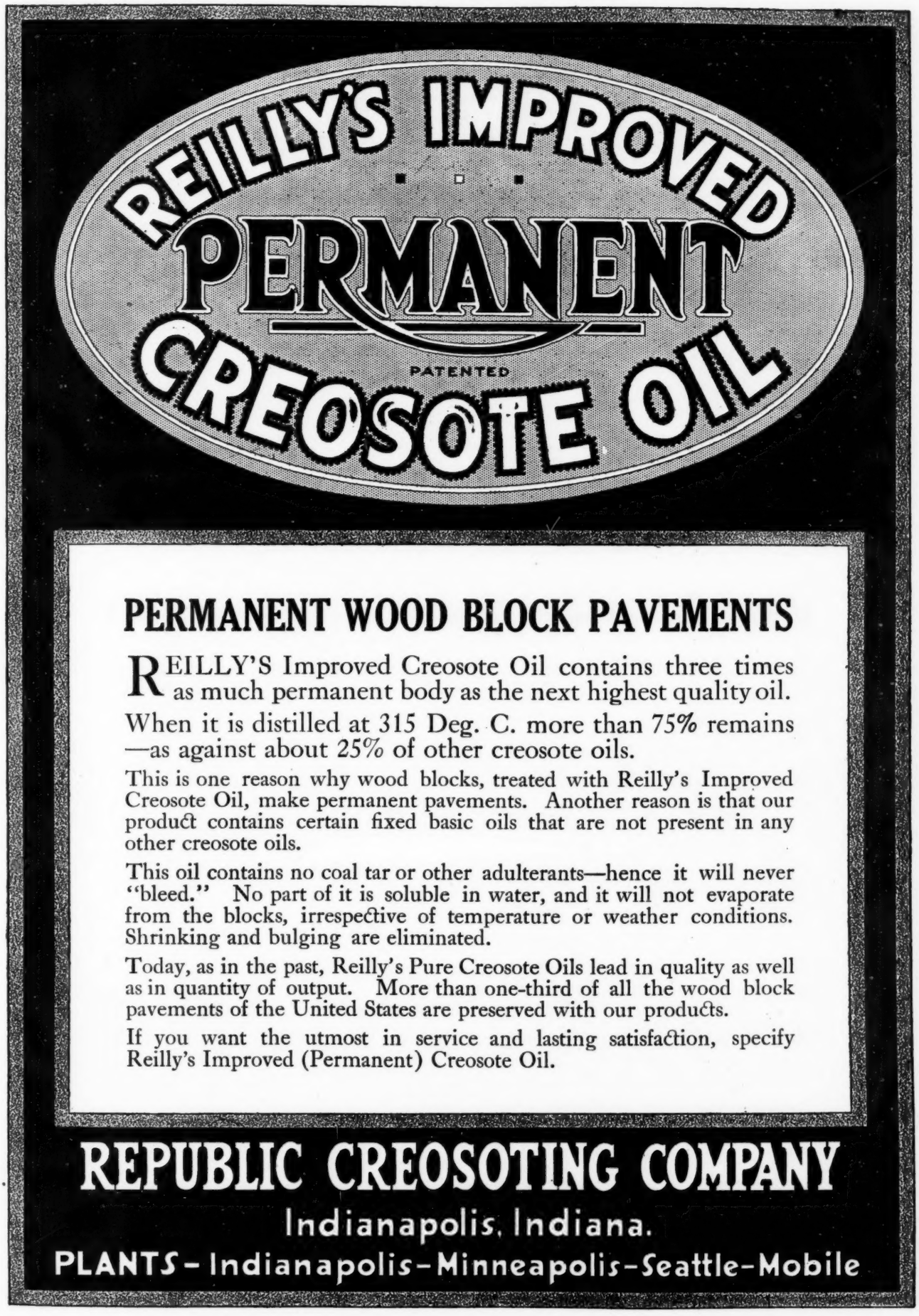
do their work with speed, economy and cleanliness, and without the objectional feature associated with the use of steam rollers.

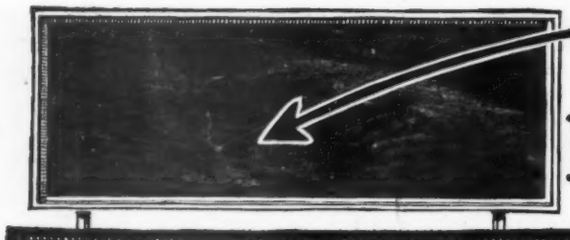


Austin Road Roller.

Austin-Western Road Machinery Company — CHICAGO

BRANCH OFFICES: New York, Columbus, Ohio, Los Angeles, Atlanta, Dallas, Portland, Ore., San Francisco, Memphis, Oklahoma City, Richmond, Va., Boston, St. Paul, Jackson, Miss.

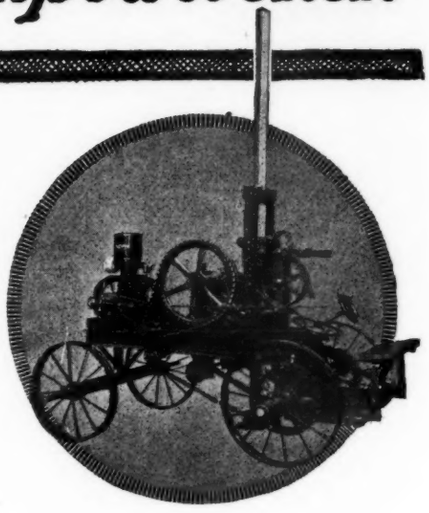

REILLY'S IMPROVED
PERMANENT
PATENTED
CREOSOTE OIL
PERMANENT WOOD BLOCK PAVEMENTS
REILLY'S Improved Creosote Oil contains three times as much permanent body as the next highest quality oil.
When it is distilled at 315 Deg. C. more than 75% remains —as against about 25% of other creosote oils.
This is one reason why wood blocks, treated with Reilly's Improved Creosote Oil, make permanent pavements. Another reason is that our product contains certain fixed basic oils that are not present in any other creosote oils.
This oil contains no coal tar or other adulterants—hence it will never "bleed." No part of it is soluble in water, and it will not evaporate from the blocks, irrespective of temperature or weather conditions. Shrinking and bulging are eliminated.
Today, as in the past, Reilly's Pure Creosote Oils lead in quality as well as in quantity of output. More than one-third of all the wood block pavements of the United States are preserved with our products.
If you want the utmost in service and lasting satisfaction, specify Reilly's Improved (Permanent) Creosote Oil.
REPUBLIC CREOSOTING COMPANY
Indianapolis, Indiana.
PLANTS - Indianapolis - Minneapolis - Seattle - Mobile



This is NOT *a* P&H *Tamped trench*

"THE P&H Power Traction Tamper pounds *every* particle of the backfill (and sometimes more) *back* into the trench (where it came from)—that's why we are *minus* any complaints caused by the settling of pavements.

"The P & H Power Traction Tamper *thoroughly* compacts *all* types of soil *more* effectively and speedily than it can be tamped by hand and at a cost (including back-fillings) of from 2 to 5½ cents per lineal foot, depending on size of trench."



No more sunken pavements because P & H Tamped Trenches do not settle.

Get details about the "P & H" Power Traction Tamper. You ought to be acquainted with this "slam-banger."

Pawling & Harnischfeger Co.
MILWAUKEE, WIS.

The Armor Plate that Wears Down Flush with the Pavement

Baker Bevel Edged Armor Plate (1⅛x2½ inches) is the universal, ever-satisfying plate for concrete roads. The impact of traffic is *downward,* and not along the surface.

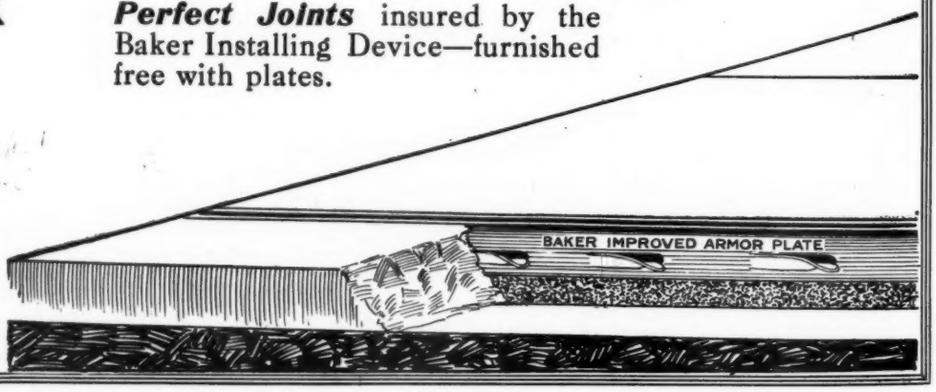
Gone!—the chipping and disintegration of concrete back of the plate—*when you use the Baker Plate. Baker's* the *improved* Armor Plate.

Perfect Joints insured by the Baker Installing Device—furnished free with plates.

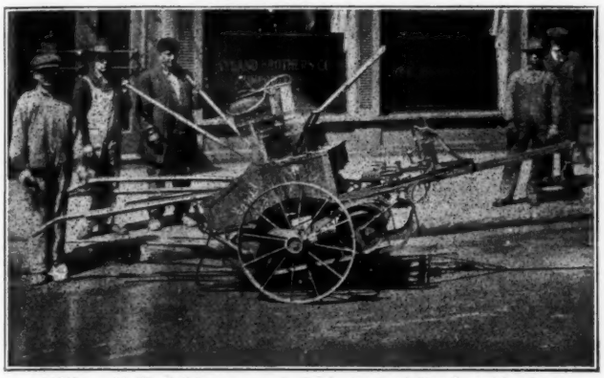
R. D. BAKER COMPANY
Penobscot Building
DETROIT, U.S.A.

Immediate Shipment Guaranteed

Write for description and prices.



A CLEANER AND HOTTER FLAME



"Phisto" Tool Furnace on the principal Boulevard of one of America's largest cities.

"PHISTO" Tool Furnace

The small, economical, kerosene-burning **"Phisto"** Tool Furnace is here to put *accomplishment* and *speed* into your asphalt pavement work.

On three gallons of kerosene per hour the **"Phisto"** will keep *14 tools, 3 pails of binder* and *3 shovel scoops constantly hot.*

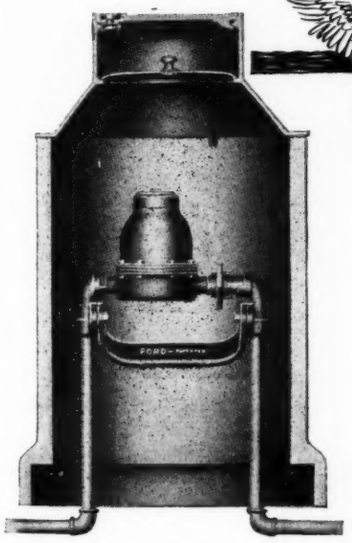
Everybody who has watched the **"Phisto"** in operation has said "Good-bye" to the old-time wood-burning furnaces, with their bothersome smoke, ashes and disagreeable fumes. The **"Phisto"** is a small, rugged, self-contained tool furnace with large capacity.

Find out all about it—*write for facts and figures.*

We have a full line of Surface Heaters, Tool Furnaces, Babbitt Burners, Torches and other special kerosene vapor burners.

ALGER SUPPLY COMPANY

Peoples Gas Building **CHICAGO, ILL.**



Ford Meter Boxes

METERS installed in **Ford Meter Boxes** are "get-at-able" any time—all the time. The meter is "always at home"—no "waiting around"—no "come back" calls and no meters damaged through tamperers or coal piles. That means meter reading and testing can easily be done with less men and in *less time.*

Here is the experience of engineer Graves, of Lansing Michigan: "By reason of use of **'Ford'** fittings, in connection with the **'Wabash'** cover, meter may be installed or removed through cover in *one minute,* and it is never necessary to dig up or disturb cover of box. Meters are always accessible for inspection and free from possible tampering! Lid locks in any position. Avoids loss of water through leaky services and no freezing."

The FORD METER BOX Co.
WABASH, INDIANA, U.S.A.

Gen. Goethals on Highway Improvements.

"I am heartily in accord with a policy which will permit highway commissioners of the various States so to plan their work that they will be able to undertake the construction of new highways and of maintaining the existing ones so as to relieve railroad congestion."

Build Permanent Highways and Save Upkeep

It is not enough to rush road building to relieve shipping congestion, but the highways must be so built as to eliminate maintenance as far as possible. Labor is so scarce that it should not be used for repairing roads.

The concrete road is permanent and requires practically no maintenance. **Kahn Highway Products** insure the best construction for concrete roads, for reinforcing, for permanent joints and for protecting concrete curbs.

Write today for Highway Pamphlet and estimates.

TRUSCON STEEL CO. TRUSCON BUILDING PRODUCTS

TRUSCON STEEL COMPANY

(FORMERLY TRUSSED CONCRETE STEEL CO.)

YOUNGSTOWN, OHIO.

WAREHOUSES AND REPRESENTATIVES IN PRINCIPAL CITIES

Kahn Road Mesh

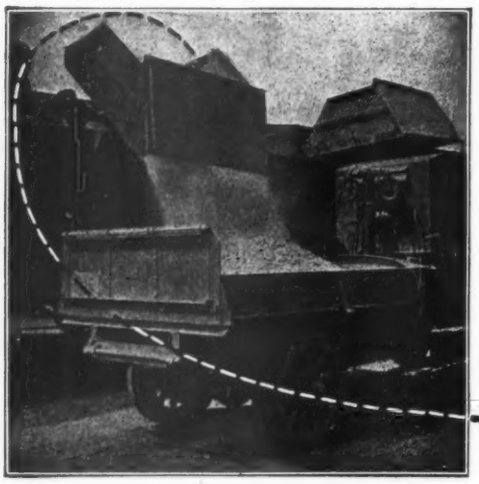
Large, flat sheets, easily handled—no unrolling of coils nor cutting to length. The most efficient reinforcement for concrete roads and pavements.

Kahn Armor Plates

Perfectly protect expansion joints. The split end prongs assure positive anchorage in the concrete, and plates are correctly placed by our Improved Installing Device.

Kahn Curb Bars

Protect and reinforce concrete curbs. Strong, rigid, convenient, easy to install. Furnished straight or curved.



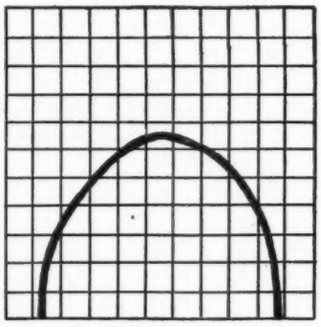


Diagram 1.

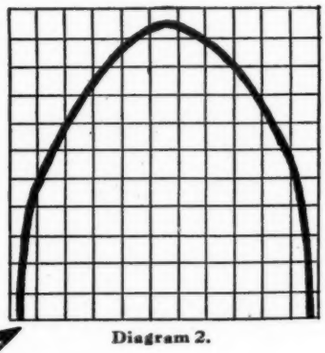


Diagram 2.

Three times the unloading capacity—with fewer shovelers—by using the Heltzel "Lightning" Loader Skip.

Diagram 1—shows your *present* capacity for unloading if you are not using the **Heltzel "Lightning" Loader Skip.** This *handicap* delays your trucks, delays the job, keeps the men loafing, and piles up on your account *$10.00 per day* demurrage charges!

Diagram 2—shows *three times* your capacity for unloading if you *use* the **Heltzel "Lightning" Loader Skip.** This advantage permits you to keep only a few shovelers busy *all the time,* keep the trucks actively moving and *hasten the work!*

Moral*—Speed up your unloading and save time and money with the Heltzel "Lightning" Loader Skip.** ***Read our illustrated literature.

HELTZEL STEEL FORM & IRON CO.

WARREN, OHIO.

The Highway Economist

WIRE CUT LUG

VOL. IV. JUNE, 1918. No. 1.

OLD-TIME ROAD BUILDING

The old-time surveyor was the forerunner of the modern engineer, and he has left his mark in many places like scars on the face of nature. But the old surveyor was as useful as the old country doctor; he was a local institution. Laying out roads was a side issue. He ran lines everywhere, and later attempts to find corner stakes, or monuments, and boundary lines, indicate that sometimes he ran lines almost anywhere. He was the expert witness in land suits in justices' courts, and his evidence was conclusive because he was the only person in the township who could read the signs of the zodiac written in his field note book. Necessity, which knows no law, presided over the traverse of the cases, and often such momentous issues as the location of Deacon Pegram's hog pen or the trespass of Widow Peabody's chickens were in litigation.

In all such cases the surveyor was subpoenaed to testify as to meets and bounds, and notwithstanding the offenses he had committed against high heaven in laying out roads, he was justly esteemed as an incorrputible witness and an authority in his professional field.

Alas! The old surveyor has passed away. His race is extinct. Even the title by which he was known has become obsolete except in the legal nomenclature of Ohio and a few other states in which county surveyors still exist. The engineer has succeeded to the throne. A new dynasty has become regnant and a new order of things has been established. The graduate of the technical school has taken the place of the self-taught surveyor, and engineering, instead of being an eclectic profession of general practice, has become highly specialized. Highway engineering is now a special branch. It is now possible for engineering errors to be made in a dozen different branches of the profession; but only a few engineers attempt general practice.

The country in early days could not have done without the surveyor. Working, ofttimes, with imperfect instruments and under the most adverse conditions; often in peril of life from beasts and men, his shrewd sense and indomitable spirit carried him through, and he performed a pioneer service which entitles him to be remembered with grateful respect.

Wonderful advances have been made in road building since the days of the old-time surveyor. One wonders what the surveyor who laid out early roads would think of a modern wire-cut lug brick road.

Springfield Wire-Cut Lug

IS WIDELY USED

The square edges *stay* square, due to the spacing lugs and beveled ends. Both Dunn Wire-Cut Lug and Frost Process. Sewer and Building Brick—also very artistic Rug Face Brick.

Springfield Paving Brick Co.

SPRINGFIELD, ILLINOIS

MEDAL BLOCK
"The Block with Experience behind it"
BUYING cheap goods to save money, is like stopping the clock to save time; and this applies to many types of road surfacing material. If you want the only sure, durable and reliable road surface, buy
23 YEARS SERVICE
MEDAL BLOCK
"The Block with experience behind it"
Manufacturers of Medal Block for 23 years.
Manufacturers of Paving Brick for 29 years.
Oldest in service unexcelled in quality.
Medal Repressed, Wire-Cut-Lug and Hillside Block.
Capacity 55,000,000 annually
THE MEDAL PAVING BRICK COMPANY
FORMERLY THE DECKMAN-DUTY BRICK CO.
1305-1308 Swetland Building
Cleveland, Ohio

Back to Brick

and the

Brick to Back

Public Demand for Wire-Cut Lug Paving Brick accounts for *eleven* additional companies engaging in the manufacture of these pavers in 1917.

47 Companies, operating 71 Plants in 12 States, are now making Wire-Cut Lug Brick.

345,070,954 Wire-Cut Lug Brick have been shipped during the past *two years*.

New highwater mark reached in 1917, notwithstanding war and transportation embargoes.

Superior merit the efficient cause of steadily increasing demand. Manufacturers profit by demand market already existing, and by the national advertising and publicity campaigns conducted by the Dunn Company, whose free advisory engineering service protects the reputation of the brick by whomsoever made against improper construction methods.

COMPANIES PRODUCING WIRE-CUT LUG BRICK

—LICENSEES—

Corry Brick and Tile Co., Corry, Pa.
United Brick Co., Greensburg, Pa.
Sterling Brick Co. Olean, N. Y.
Danville Brick Co., Danville, Ill.
Clinton Paving Brick Co., Clinton, Ind.
Alton Brick Co., Alton, Ill.
The Medal Paving Brick Co., Cleveland, Ohio.
Metropolitan Paving Brick Co., Canton, Ohio.
Peebles Paving Brick Co., Portsmouth, Ohio.
Murphysboro Pav. Brick Co., Murphysboro, Ill.
Southern Clay Mfg. Co., Chattanooga, Tenn.
McAvoy Vitrified Brick Co., Philadelphia, Pa.
Windsor Brick Co., Akron, Ohio,
Hocking Valley Brick Co., Columbus, Ohio.
Veedersburg Paver Co., Veedersburg, Ind.
Springfield Paving Brick Co., Springfield, Ill.
Terre Haute Vitrified Brick Co., Terre Haute, Ind.
Albion Vitrified Brick Co., Albion, Ill.
Alliance Clay Product Co., Alliance, Ohio.
Westport Paving Brick Co., Baltimore, Md.
Mack Mfg. Co., New Cumberland, W. Va.
Hydraulic-Press Brick Co., St. Louis, Mo.
Barr Clay Company, Streator, Ill.
Thornton Fire Brick Co., Clarksburg, W. Va.
Indiana Paving Brick & Block Co., Brazil, Ind.
Standard Brick Co., Crawfordsville, Ind.
Shawmut Paving Brick Works, Shawmut, Pa.
Pennsylvania Clay Co., Pittsburgh, Pa.
Clydesdale Brick & Stone Co., Pittsburgh, Pa.
The John Kline Brick Co., Wickliffe, Ohio.
Streator Clay Manufacturing Co., Streator, Ill
Martinsville Brick Co., Martinsville, Ind.
Cleveland Brick & Clay Co., Cleveland, Ohio.
Jamestown Shale Pav. Brick Co., Jamestown, N.Y.
Purington Paving Brick Co., Galesburg, Ill.
Georgia Vitrified Brick & Clay Co., Augusta, Ga.
F. R. Carter, Peoria, Ill.
C. P. Mayer Brick Co., Bridgeville, Pa.
Athens Brick Co., Athens, Ohio.
Albion Shale Brick Co., Albion, Ill.
Copeland-Inglis Shale Brick Co., Birmingham, Ala.
Brick, Terra Cotta and Tile Co ; Corning, N. Y.
Medora Shale Brick Co., Medora, Ind.
Binghamton Brick Co., Inc., Binghamton N. Y.
Municipal Shale Br'k & Bl'k Co., Martinsb'g, W.Va.
Lake Shore Shale Brick Co., Ashtabula, Ohio.
Allegany Valley Brick Co., Olean, N. Y.

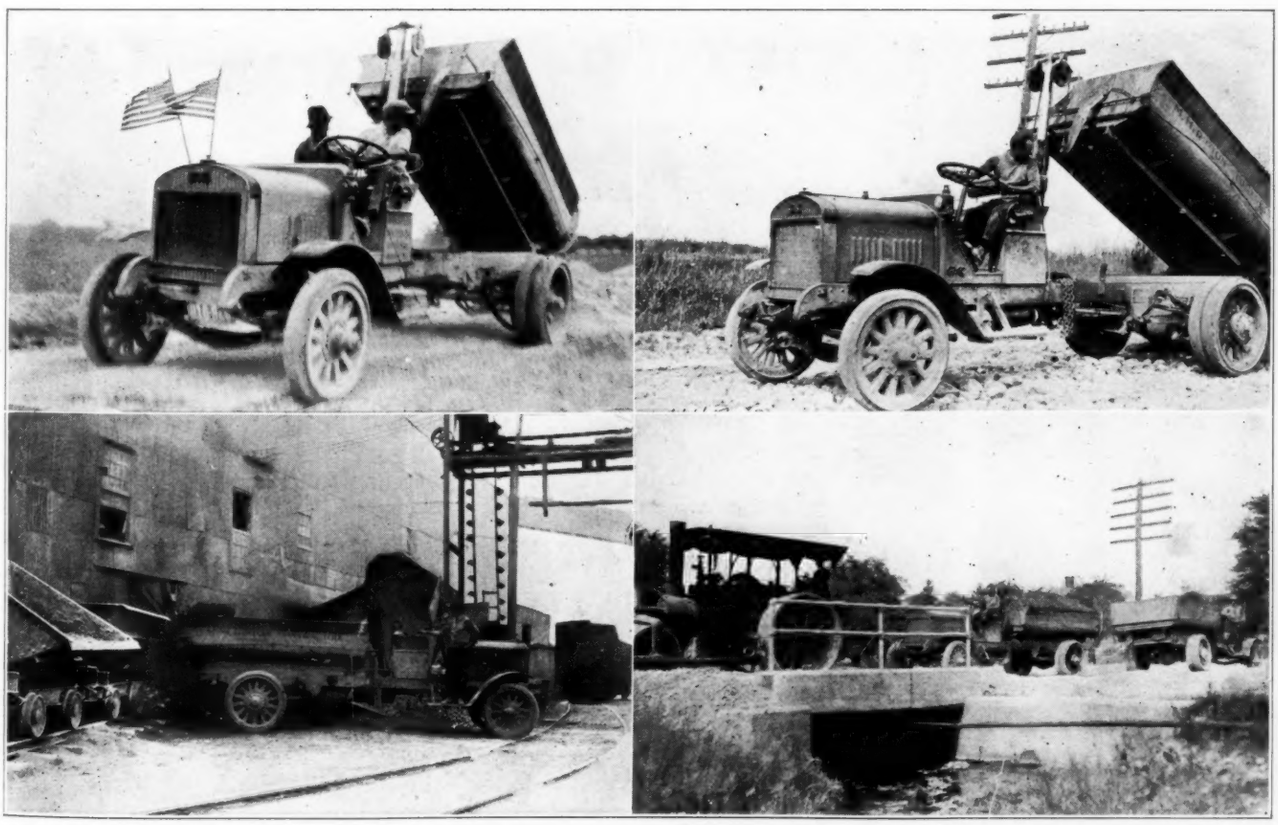
Write for data.

THE DUNN WIRE-CUT LUG BRICK CO., Conneaut, Ohio.

(LICENSORS)

MOTOR TRUCKS

Motor Trucks as Operated in the Construction and Maintenance of Country Roads and City Streets.



G. M. C. TRUCKS AS OPERATED BY NEW YORK CONTRACTORS ON ROAD AND STREET CONSTRUCTION.

Printed as insert to Municipal Engineering, June, 1918.

Mack
TRUCKS

MACK COMPETENCY

By constant, day-after-day service through all seasons of the year, MACK trucks prove their remarkable stamina and their wonderful reliability. Speed on ordinary roads, power on hard, steep climbs, economy through great haulage ability—these are facts that make the MACK a most efficient and competent truck.

Operated from the seat, the powerful MACK hoist raises the body to an angle of 40°—from this pitch any load slides off readily. Dumping is quick and easy. This speed in unloading makes more hauls possible, and lessens the cost per ton mile. The hoist is but one of many paying features that MACK engineering skill has adopted for practical use.

Write for MACK performances in your line of business.

MACK trucks are made in sizes from 1 to 7½ tons capacity; with trailers, up to 15 tons. Special bodies can be designed to meet specific needs.

INTERNATIONAL MOTOR COMPANY
NEW YORK

Performance Counts

The Trend of the Times—*Motorize*
The Motor Truck of the Times—
GARFORD

The times demand action.

Production has broken all bounds. Transportation bears the brunt. It must hold up.

The highways must accommodate the overflow. The very life-blood of commerce pulses in these great arteries of progress.

And you are a part of this great scheme.

Your business is one of the vertebræ in the backbone of the Nation.

Are you speeding it up? Are you putting the punch into production.

It is just as far from California to Maine as it is from New York to Paris. We could put the whole Western front into the State of Texas and have miles to spare.

Our very vastness calls for intensified transport.

The answer is motorization. And this means motor trucks in your business.

Then investigate the Garford Motor Trucks. They are economical, dependable, tenacious. Tried and proven through long years of staunch service.

Bought by business men on a business basis. Why wait and waste time?

Decide on Garford today. There is a Garford to fit your purpose.

Catalog on request—Address Dept. 107.

The Garford Motor Truck Company, Lima, Ohio

Manufacturers of Motor Trucks of 1, 1½, 2, 2½, 5 and 6 ton capacity
4½, 7 and 10 ton Tractors
The Garford Road Builder

Making Municipal Trucks Profitable

The conduct of municipal transportation in as economical and efficient a manner as that of a private enterprise depends in no small part upon the care and judgement used in the selection of vehicles to do the work.

Economy has already selected the motor truck as the best method of city hauling and all other similar work.

A large number of state, county and city governments have selected GMC as the standard truck for their fleets.

The adaptability of GMC to every demand of public business, whether the heavy hauling of the road department or the speed and flexibility of the fire truck and ambulance, makes GMC Trucks ideal for public needs.

A super strength in every part, much greater than the average strain will need to care for it properly, a simplicity that reduces repairs and replacements to a minimum, and an economy of operation that allows of a big saving in maintenance costs, are three prominent features of GMC value.

More than that, and of paramount importance in standardizing a fleet is the fact that GMC Trucks are built in all practical sizes.

Some GMC, from the three-quarter ton to the heavy duty five-ton chassis, is the truck that fits into a specialized municipal occupation.

And GMC dealers, as well as truck headquarters, offer the experience of every other municipality using GMC to guide the fitting of the truck to the job.

GENERAL MOTORS TRUCK COMPANY

One of the Units of the General Motors Corporation

New York Philadelphia Boston **PONTIAC, MICH.** Chicago St. Louis San Francisco

Distributors most Everywhere

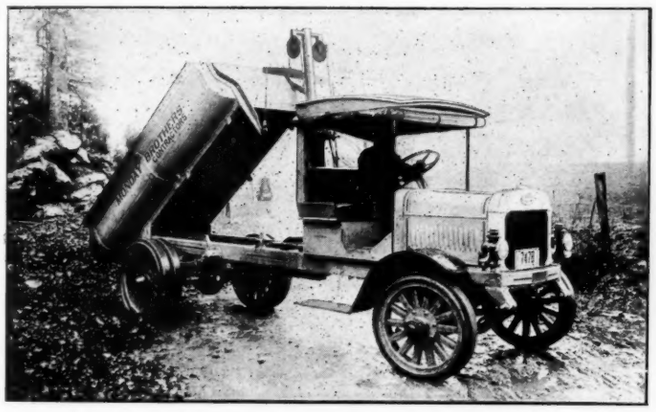
(353)

MOTOR TRUCK OPERATION AND ACCOUNTING XXXIV

The economy effected by the use of motor trucks in the construction of country roads and city streets is generally appreciated by those engaged in the construction industries. Herewith are given some facts and figures pertaining to trucks as operated in road and street construction.

New York Contractors Save Money with G M C Trucks

M. H. Ripton, of Rochester, N. Y., has two G M C 5-ton trucks which he used last spring in road construction work, and through the use of the trucks was enabled to make good his contract and make some money, whereas the use of teams would have netted a loss. The reason in this particular instance was that there was so much wet weather, there being days at a time when the work could not be carried on. On account of the scarcity of help, he states that the only possible way he could have had the teams and men to do the work



3½-TON GRAMM-BERNSTEIN DUMP TRUCK, AS OPERATED BY MONDAY BROTHERS, KNOXVILLE, TENN.

when the weather was so it could be done, would have been to keep these men and teams on the job in bad weather, and as it would have taken from 12 to 15 teams with drivers, it is easy to see how the expense would have piled up during the days when no work could be done. On the other hand, with the two trucks it was necessary only to keep the two drivers constantly, and then they were ready at any time to go out on the work, even though for only three or four hours at a time. During idle times the only expense was the wages of the two drivers as against the wages of 12 to 15 teamsters and the expense of horse feed.

The Ribstein & Holter Co., New York road and street contractors, also successfully employed G M C trucks on this class of work. Mr. Ribstein states that the trucks were much more profitable than teams, for the reason that with teams only 1½ cu. yds. of material could be hauled, as against 5 cu. yds. per load by truck. Moreover, the teams could make only four trips a day, against ten trips by the trucks on the same job. He also states that during 1916 he had a contract on a certain piece of road where there was one hill up which it required three horses to haul one yard of material. This contract was taken with the belief that the necessary material could be had close by the job, where teams would have been quite effective on account of the short distance of transporting the material. It developed after the work started that the local material was not suitable, and material had to be hauled a distance of several miles. Mr. Ribstein stated that by doing the work with the trucks he made a little money, whereas had he been compelled to finish the contract with the use of teams, he would have lost $10,000.

Comparison of Horse and Motor Haulage

The motor truck was adopted because it was evident that such equipment would be much more efficient than horse-drawn vehicles. The average motor truck moves loads much heavier than could be hauled by teams, in about one-fifth the time required by horses; or, to state it differently, the 2-ton motor truck will move an average 2-ton load about 120 miles in 10 hours' time, employing 2 men, a driver and a helper; to move 2 tons 120 miles by horse-drawn vehicle would require one team and two men about four days or four teams and eight men one day. Experiments and accurate cost records conclusively prove that a 2-ton motor truck can be operated more cheaply than can a team and wagon. The above statement shows that the motor truck is 300 per cent. more efficient than the horse-drawn vehicle.

The adoption of motor trucks on construction work is generally soon followed by the adoption of labor-saving machinery of other types. For example, the portable loader will load in from 4 to 6 minutes a 108-cu.ft. dump body, which, under average conditions, could not be loaded by a hand shoveler in less than 1¼ hours. Road contractors are adopting trucks and portable loaders for moving sand, gravel and crushed stone from the source of supply to the point of its use.

Cost Data of Truck Operation in Iowa Highway Work

The figures given herewith in Table I are based on the experience of four Iowa counties in the use of trucks on road

TABLE I—COST OF OPERATING MOTOR TRUCKS ON IOWA ROAD AND BRIDGE WORK.

County—Truck	Original Cost	Date Started	Nature of Work	Mileage 1917	Miles per Gal. of Gas.	Average Load in Tons
Mitchell, well known 5-ton truck	$5,818	Aug. 1, 1917	Hauling road gravel	1,457	1.37	7.4
Worth, well known 5-ton truck	5,700	June 1, 1916	Hauling road gravel	2,000	1.21	7.0
Butler, Duplex 3½-ton truck	3,825	May 16, 1917	Hauling bridge gravel	5,446	4.50	4.2
Black Hawk, Duplex 3½-ton truck	3,883	June 25, 1917	Hauling bridge gravel	6,783	3.68	4.0

—Operating Cost 1917—

County	Gas	Oils	Repairs	Driver	Loading	Total	Ton Miles	Cost Ton Mile
Mitchell	$231	$269	$ 16	$258	$465	$1,239	5,348	23.2c
Worth	354	138	341	211	475	1,519	7,000	21.7c
Butler	321	75	58	816	629	1,899	11,978	16.9c
Black Hawk	436	57	175	531	530	1,729	13,564	12.8c
Average	$335	$135	$148	$454	$525	$1,596	9,472	16.9c

—Investment Cost 1917—

County	Depreciation	Interest	Total	Cost Ton Mile	Days Operated	Grand Total Cost Per Ton Mile
Mitchell	$1,309	$160	$1,469	27.5c	49	50.7c
Worth	1,282	157	1,439	20.5c	54	42.2c
Butler	861	105	966	8.1c	128	25.0c
Black Hawk	874	107	981	7.2c	125	20.0c
Average	1,081	132	1,213	12.8c	89	29.7c

For Flushing and Sprinkling

at maximum speed and lowest cost, municipal officials find their *final* answer in a Service Motor Truck.

The integrity of its makers, its established reputation for consistent performance, its unassailable position among the "Dominant Seven" are guarantees of economy and dependability never questioned.

The City of Chicago recently substantiated this statement by purchasing *seven* heavy duty Service Motor Trucks at one time. The list of cities and counties using them grows steadily.

Officials who are disinclined to speculate and experiment can perhaps save themselves and the people they represent a considerable amount of time and money by following Chicago's example.

There is a Service for every purpose—1 to 5 tons. The price is lower than any other member of the "Dominant Seven," but its performance will equal that of *any* truck, regardless of price.

For Flushing Sprinkling Oiling

Service MOTOR TRUCKS

For Light and Heavy Hauling

SERVICE MOTOR TRUCK CO., Wabash, Ind.

Distributors in all Principal Cities.

Chicago, Ill.	Omaha, Neb.	Buffalo, N. Y.	Baltimore, Md.	Pittsburgh, Pa.	Philadelphia, Pa.	Knoxville, Tenn.	Toledo, Ohio
New York, N. Y.	Boston, Mass.	Salt Lake City, Utah	Columbus, Ohio	Washington, D. C.	Rochester, N. Y.	Memphis, Tenn.	Billings, Mont.
Norfolk, Va.	Brooklyn, N. Y.	Milwaukee, Wis.	Cincinnati, Ohio	Savannah, Ga.	Tulsa, Okla.	Birmingham, Ala.	Seattle, Wash.
St. Louis, Mo.	Newark, N. J.	Bridgeport, Conn.	Youngstown, Ohio	New Orleans, La.	Detroit, Mich.	Dayton, Ohio	Spokane, Wash.
Louisville, Ky.	Indianapolis, Ind.	Des Moines, Iowa	Canton, Ohio	Hoboken, N. J.	Denver, Colo.	Nashville, Tenn.	

TABLE II—PERFORMANCE OF MOTOR VEHICLES IN ROAD MAINTENANCE WORK IN ILLINOIS IN SPRING OF 1917.

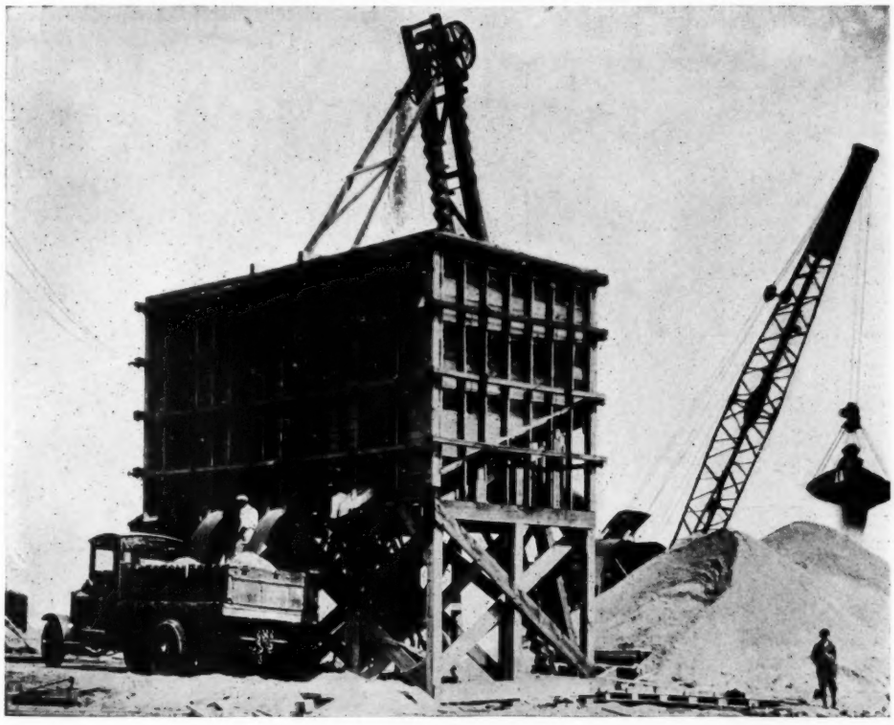
Truck No.—Operator—Type of Truck	Mileage	Gasoline Used			Gasoline	Total Cost of Operation	
		Gallons	Cost Dollars	Miles per Gal.	Cost per Mile	Dollars	Cts. per Mile
1—W. B. Fishel—Ford with Trailer.....	1,926	118	$28.73	16.3	.0149	$76.71	3.98
2—C. B. Watkins—Smith Form-a-Truck.....	1,831	139.5	31.73	13.1	.0175	67.08	3.66
3—Besta Hines—Ford	1,376	143	38.61	9.63	.028	62.03	4.58
4—R. L. Stover—Smith Form-a-Truck.....	1,293	141	27.68	9.18	.0214	43.06	3.33
5—P. W. Miller—Ford	2,300	151	30.52	15.2	.0133	55.27	2.40

and bridge work in 1917. Two of the trucks were Duplexes, the other two were 5-ton trucks of two different makes.

Cost Data on Truck Operation by Illinois State Highway Department

Frank T. Sheets, assistant maintenance engineer, Illinois State Highway Department, has given out some interesting data on the use of small trucks by the department in road maintenance work in 1917. Table II herewith gives the data from the start of the season of 1917 to May 26, 1917. Attention is called to the fact that in figuring the cost of operation per mile no consideration is given interest on investment, depreciation or wages. The cost per mile, given in the last column of Table II, covers just the cost of gasoline, oil and incidental repairs. Mr. Sheets says:

"The State Highway Department now has in operation five small maintenance trucks which are used in keeping up the widely scattered mileage of state-aid roads in Illinois. The principal work consists of filling cracks in concrete roads.



FEDERAL 5-TON TRUCK BEING LOADED WITH SAND AT ELEVATOR, AS OPERATED BY MILBURN CARTAGE CO., DETROIT, ON STREET PAVING WORK.

"Truck No. 1 is an ordinary Ford runabout, fitted with a box for hauling materials. This truck pulls a trailer, which carries heating kettle and miscellaneous tools. Trucks No. 3 and No. 5 are also Ford runabouts, to which small boxes and heating kettles have been attached. Trucks No. 2 and No. 4 are Ford cars fitted with Smith Form-a-Truck attachments. All of these cars have proved very efficient in performing the class of work required of them.

"Table II gives the mileage and the cost of operating these machines from the beginning of spring to May 26. The heading, 'Total Cost of Operation,' includes all incidental repairs, but does not include interest on the investment, depreciation or the cost of new tires recently purchased."

The average investment in a Smith Form-a-Truck of standard type, including the value of the chassis, is about $850. Figuring 6 per cent. interest on this investment and depreciation at 10 per cent., the annual charge for these two items would amount to $136. The time coverd by Table II is about three months, therefore one-quarter of $136, or $34, rightfully should be charged to the maintenance account of each truck.

It is impossible to say how many days the trucks were in service during the period under consideration, which approximately covers the three months of March, April and May, 1917. Judging from the low mileage, they certainly were not used continuously. For this reason it is impossible to say what wages should be charged into the cost of operation. But in comparative statements of truck and horse cost in contracting service it has become almost conventional to figure on a 50-mile day for a motor truck.

Upon this basis, truck No. 2 would have worked 33 1/3 days and truck No. 4 26 days. Allowing $3 a day for the wages of a driver, the wage cost to be added would be $100 and $78, respectively.

This would make the total cost for the period covered $201.08 for truck No. 2 and $155 for truck No. 4. On the mileage basis this figures 10.9 cts. per mile for truck No. 2 and 12 cts. per mile for truck No. 4.

Some of these figures are assumed, but they are based upon averages which have pertained in motor truck operation in similar work, hence they are probably approximately correct.

Using Trucks to Haul Other Road Machinery

Trucks are much used in hauling other types of road-making machinery. For example, a Duplex truck recently furnished the power for drawing an Uncle Jim road leveler in a test on a road job near Waterloo, Iowa. Six men stood on the blade of the leveler, burying it to a depth of 8 in. The truck handled the load easily and soon distanced the powerful tractor, ordinarily used to draw the leveler, that was trying to keep up during the test.

Escambia county, Florida, has in service a Kelly-Springfield

Strength to Withstand Terrific Strains

The Gramm-Bernstein Frame is made of Cold Pressed Channel Section Steel one-quarter inch in thickness, and there are six powerful cross members.

Proper distribution of weight assures protection against the most terrible strains. The transmission is mounted midway between motor and rear axle. This puts the weight where it should be, and it makes the transmission always easily accessible—it permits the use of two short drive shafts instead of one long shaft.

There are no radius rods on a Gramm-Bernstein Truck. Drive and torque are taken through the rear springs. Special spring construction makes this highly desirable. It takes the shocks off the rear axles. And it means less broken springs also. This enables us to give you an unusual guarantee. *We guarantee the springs for the life of the truck.*

The GRAMM-BERNSTEIN MOTOR TRUCK CO.

Lima, Ohio.

TABLE III—COMPARATIVE UNIT COSTS OF OPERATING SEVEN MOTOR TRUCKS BY SEATTLE STREET AND SEWER DEPARTMENT IN 1917.

		Average Cost Per			Average Miles Per Gallon				Cost per	Tons per	Tons per	
	Miles	Day	Mile	Gas and Oil Mile	Day	Gas	Quart Oil	Tons	Ton	Day	Trip	Trips
Gramm—1910—3 T	5,014.0	$ 6.77	$0.209	$0.033	32.2	3.84	13.5	2,532.7	$0.415	16.28	2.67	948
Gramm—1911—3 T	8,922.8	6.57	.192	.031	34.1	3.88	20.7	6,387.5	.269	24.42	3.23	1,974
Velie—1914—1 T	8,044.7	6.79	.195	.024	34.7	4.89	34.52	4,026.5	.390	17.4	1.26	3,167
Gramm—1912—3 T	6,788.2	7.06	.224	.038	31.42	3.54	11.05	5,201.6	.293	24.08	3.56	1,460
P-A—1912—5 T	6,784.8	7.34	.227	.037	32.29	3.16	24.2	5,517.9	.279	26.26	3.75	1,468
*G. M. C. Eductor—1915—3½ T.	4,870.3	10.49	.367	.046	28.56	2.51	27.57	3,220.0	.555	18.88	3.77	853
Velie—1916—2½ T	6,960.0	8.03	.197	.026	40.8	4.48	28.6	1,903.6	.72	11.16	2.23	852
Totals	47,384.8	$7.47	$0.223	$0.029	32.7	3.71	21.1	28,789.8	$0.367	20.3	2.69	10,722

* The G. M. C. Eductor is a catch-basin power-cleaning machine.

dump body truck. The truck is put to a variety of uses. Beginning with the first operation in road-building, they draw the grader in opening up the side ditches and grading the roadway. They haul the material and draw the roller with which it is rolled. They bring all equipment to the work and carry the workmen back and forth to the job.

Performance of White Truck on Kentucky Roads

Robert W. Davis, county engineer of Fayette county, Kentucky, writes as follows of his experience in the use of motor trucks and trailers in road construction and maintenance work:

"A few years ago the cost of hauling over country roads was thought to be well established for ordinary conditions. Accurate cost data collected under varying conditions established a reasonable accurate ton-mile estimating cost of hauling with teams as varying between 20 to 30 cts. New developments in machinery have, however, placed at the disposal of the road engineer and contractor other methods of hauling, which, under proper conditions, are much more economical than team hauling.

"The steam and gasoline tractor with wagon trains, the motor truck alone, or with trailers, each has a definite field in which its use results in a saving over any other method that might be employed. In selecting between these classes of mechanical powers, the roads they are used over must be considered. The truck being built for speed as well as power, on favorable roads, can cover twice as much ground per day as the steam or gasoline tractors.

"The following will show the accomplishments per day of a White good roads truck and two Troy trailers, operated on Fayette county, Kentucky, roads. I have not figured the depreciation and interest on investment involved, but just intend to show a day's work done by a modern road-hauling train.

February 16. Truck alone. Covered 56 miles; hauled 18 tons. Cost for operations, $6.73. (Gas., 18 gals. at 12 cts.; 2 men, $4.25; oil, 32 cts.) Cost per ton-mile, 6.6 cts.

February 17. Truck and one trailer. Covered 48 miles; hauled 31½ tons. Cost of operation, $7.61. Cost per ton-mile, 5 cts.

"February 18. Truck and two trailers. Covered 48 miles; hauled 45 tons. Cost for operation, $8.73. Cost per ton-mile, 4 cts.

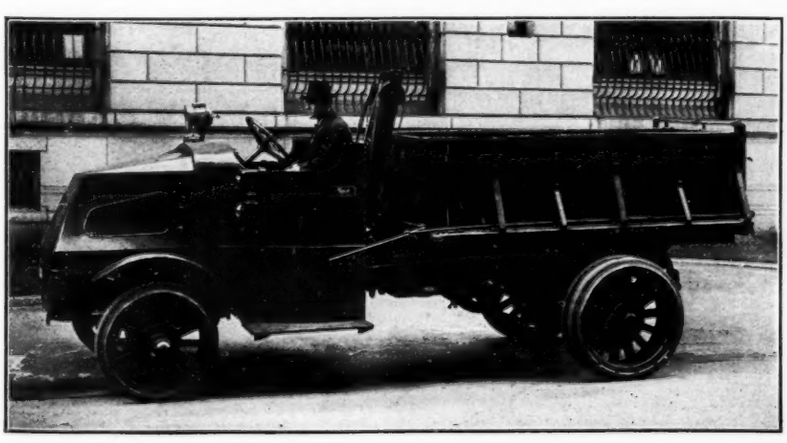
"You will notice where one trailer was used, 13½ tons were delivered for 88 cts., and where the two trailers were used 27 tons were delivered for $2. If the last day's hauling had been by teams at $3.50 per day it would have taken 15 teams, costing $52.50, as to $8.73 for truck and trailers, making $43.77 for county in one day. The trailers used were Troy truck 4-yard trailers. Since we can see the efficiency of any hauling outfit is in proportion to its ability to deliver material cheaply."

Truck Operation in Seattle

A great saving was effected in the cost of operating the motor trucks of the Street and Sewer Department of the city of Seattle by keeping accurate cost records. A study of these records made possible the reduction of the daily operating cost of trucks from $12 to $15 in 1913 to an average of $7.47 in 1916 and $8.81 in 1917. The higher cost for 1918 is due to higher prices of labor and materials.

Table III herewith gives the comparative unit costs of operating 7 motor trucks in the service of the Seattle Street and Sewer Department in 1917.

Dump Truck Powered with Wisconsin Motors
CONSISTENT
The standard power for municipal trucks
Write for specifications on different types and sizes.
WISCONSIN MOTOR MFG. CO.
Station A. Dept. 330
MILWAUKEE, WIS.
New York Branch, 21 Park Row,
T. M. FERNER, Factory Rep.



MACK 3½-TON DUMP TRUCK, AS OPERATED BY FASSETT & RUDY, HAULING CONTRACTORS, PORTLAND, ORE.

In War Preparations

In the rush work of building cantonments to receive the National Army, the Pierce-Arrow played an important part everywhere, doing more work in less time—and with less idle time—than any other truck employed.

Wherever competitive tests of this sort occur, the Pierce-Arrow invariably proves most efficient.

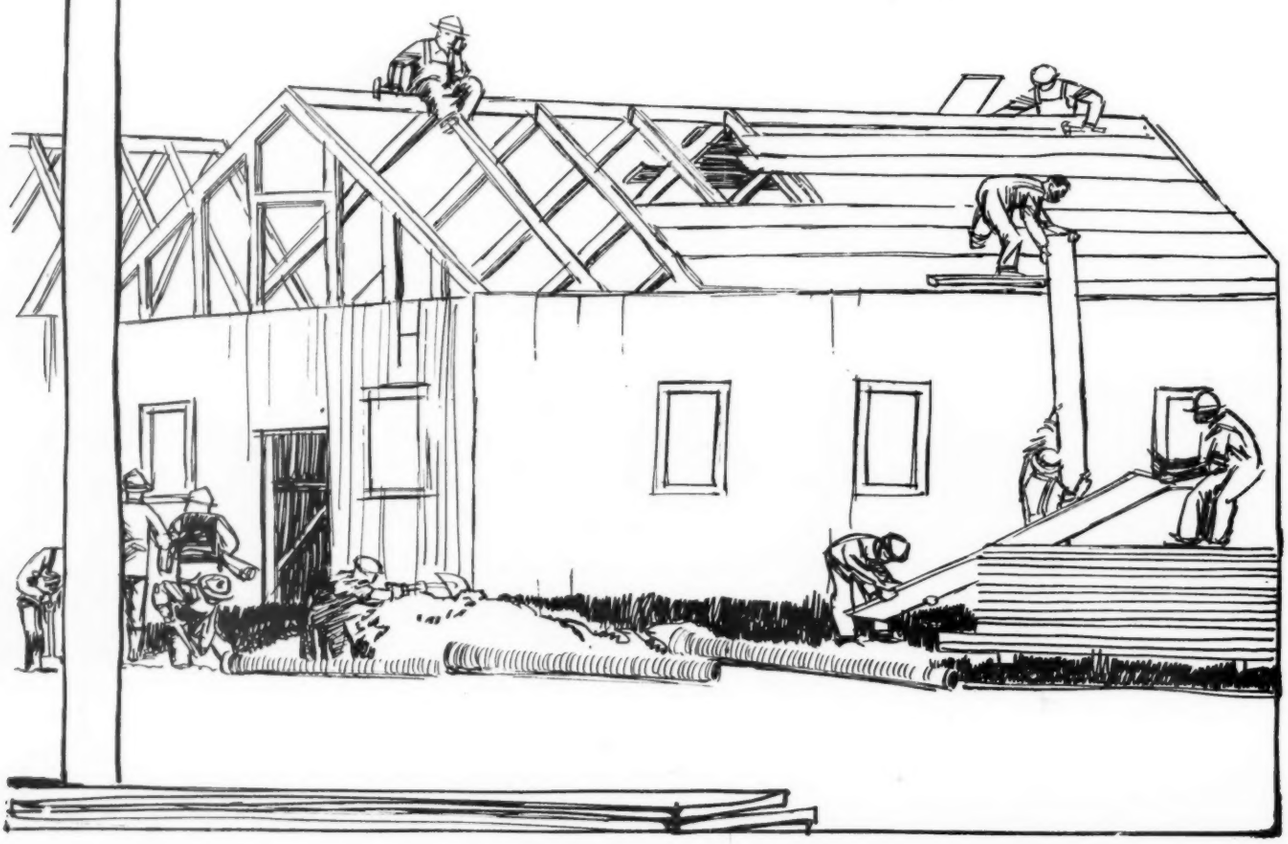
A case in point was at Camp Taylor. Here a fleet of six Pierce-Arrows, owned by the Ohio River Sand Company, operated by two shifts of drivers four nights a week, made continuous runs of 192 hours.

Hauling sand and gravel from the point of supply to the camp, these trucks made six round trips in every ten-hour day as compared with the maximum of five round trips for any other truck employed on the work.

Their owners say that this record is a typical index of relative value.

Each of this fleet of six trucks has averaged 19,000 miles a year and been in constant service since they were purchased.

THE PIERCE-ARROW MOTOR CAR COMPANY, BUFFALO, N. Y.



In Emergency Work

Pierce-Arrow Motor Trucks have made remarkable records in emergency work incidental to the war—in many different lines of industry—in hundreds of perplexing situations.

Day by day, they are doing their bit, without fuss, with unfailing regularity. On each job, they consistently do more than is expected of them — meeting overdrafts regularly, as it were.

This super-service is due to basic soundness of design and extreme care in building, in the selection of materials, methods and men. It is inborn in all

PIERCE-ARROW

Motor Trucks

The Worm-Gear

All Pierce-Arrow trucks are equipped with the worm-gear drive which is a positive guarantee of effective service under the most difficult conditions.

This certainty to meet the emergency is the most valuable asset you can acquire when you buy your truck equipment.

The Seal of Dependable Performance

ACME THE TRUCK OF PROVED UNITS

Trade Mark Reg. U. S. Pat. Off.

Judge the ACME *in Advance*

In municipal hauling, more than in any other industrial work, is it necessary to know in advance the performance of your truck.

That is why the **Acme** dominates the field in this respect, for you know in advance that the Continental motor is right; that Timken worm-drive axles and bearings are right; that the Bork & Beck clutch is the best the world knows for trucks, and that every part of the **Acme** is the pinacle of engineering perfection.

ACME

Proved Units Are Combined Perfections

HELP WIN THE WAR

Relieve the Railroads

Reduce your delivery costs and end delay with the ACME in your service

Get Our New Book

One of the greatest treatises on motor trucks is the great new Acme book, *"Pointers to Profits,"* which contains facts about municipal hauling that are undoubtedly worth money to you. The book is yours for the asking. Write today to

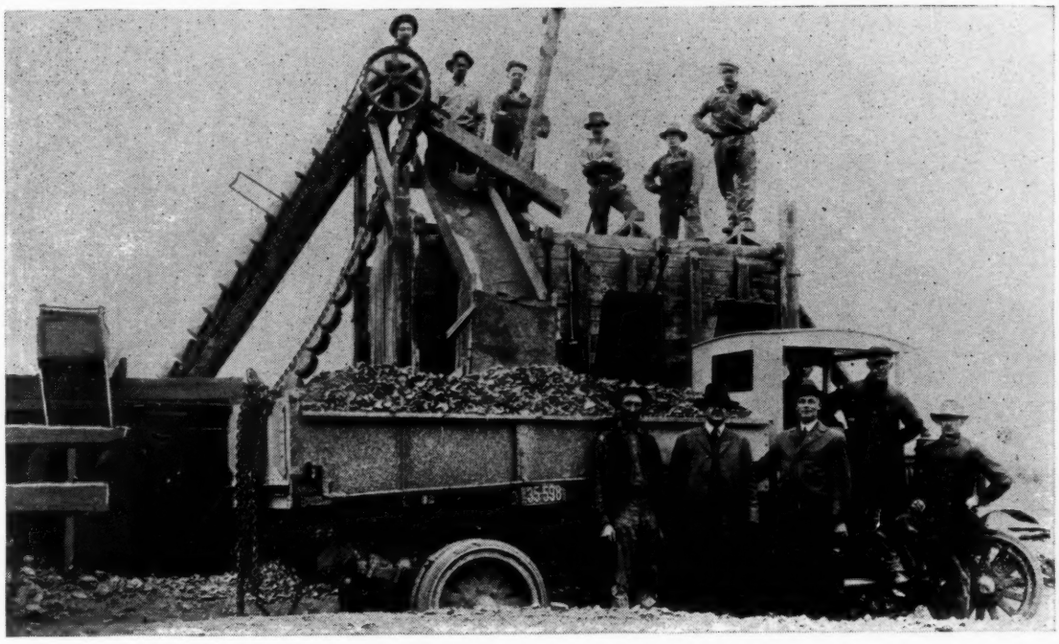
ACME MOTOR TRUCK COMPANY

222 Mitchell St. Cadillac, Michigan

One-ton to Four-ton Models. Each oversized in both capacity and dimensions.

Proved Units of ACME Construction

Continental Motor
Timken Axles
Timken Bearings
Timken-David Brown Worm Drive
Cotta Transmission
Borg & Beck Clutch
Ross Steering Gear
Blood Bros. Universal Joints
Smith Pressed Steel Frame
Detroit Springs
Hayes Artillery Type Wheels
Eisemann High Tension Magneto
Rayfield Carburetor
Stewart Vacuum Feed
Tubular Type Truck Radiator
Centrifugal Type Governor



The Kissel "Heavy Duty" Road Builder at Boulder, Colorado.

Proven Ability for Street and Highway Construction

The Kissel "Heavy Duty" Road Builder about to discharge its load.

The Kissel "Heavy Duty" Road Builder spreading its load.

Kissel Trucks are now seeing continuous service in rushing to completion those highways vital to the country's overland and interstate transportation requirements.

For the past ten years, Kissel has built-in to Kissel Trucks those mechanical features that assure service dependability vital to public highway and street construction work.

KISSEL TRUCKS

The Kissel-built power-plant fully measures up to power requirements for road-building work. The perfected worm-drive rear axle, superior front axle, dependable brakes and sturdy springs, insure uninterrupted performance necessary in trucks for contractors' use.

See your nearest Kissel dealer for specifications and prices.

Kissel Motor Car Company
Hartford, Wisconsin, U.S.A.

DUPLEX 4-WHEEL DRIVE TRUCKS

Built for Year-'Round Service

DUPLEX 4-WHEEL DRIVE

11th YEAR

The DUPLEX, shown above, is returning with a 7-ton load from a 10-mile trip across Oklahoma oil fields. Lack of roads and the ease with which the 3½-ton truck hauled its load over fields and across streams led oil operators to declare that "no road is still a road for the Duplex."

With the sun shining brightly and highways hard and dry, we often fail to take into consideration weather and road conditions as they will be six months from now, when buying motor trucks.

Demand a motor truck that is 100 per cent efficient in winter or summer—a motor truck that will haul capacity loads through hub-deep mud, over slippery clay roads and up ice and snow-covered hills—a motor truck that is on the job 365 days in the year.

The Duplex is never put in storage during the winter months.

It is giving year-'round service because the Duplex 4-wheel drive principle and Duplex-Adler differentials insure dependability under most extreme weather and road conditions.

With the front wheels always ***pulling*** and the rear wheels always ***pushing,*** the Duplex has the inherent strength and power to "get there" in spite of rain, snow and blizzards.

Let us send you Duplex haulage facts and figures for your particular business. Write for "Duplex Doings," issued in the interest of economical and better transportation methods.

DUPLEX TRUCK CO., 2050 Washington Ave., **Lansing, Michigan.**

Another FEDERAL

Federal at work on Pasadena streets, hauling away refuse and pulling an asphalt oven at the same time.

Federal Service—One Feature of Pasadena's Good City Government

PASADENA, California, is known the country over as one of the best governed cities.

Every department of the commission form of government has been developed to a high point of efficiency.

It is significant that the street department utilizes Federal Service. After careful investigation the Federal Truck was selected because it combined the utmost serviceability with unusual economy.

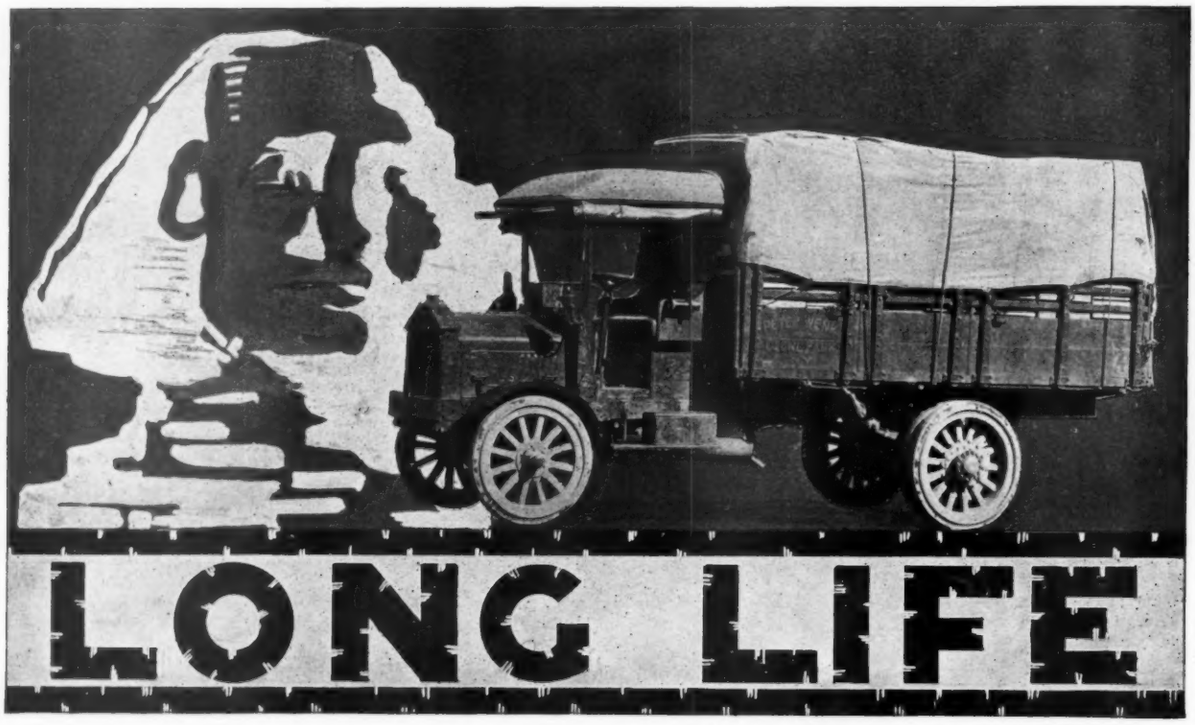
The Federal Service in Pasadena includes street cleaning, transporting street repairing machinery, hauling away broken asphalt, etc. Quick trips are made—heavy loads are hauled.

The experience of other progressive cities with Federal Service is discussed fully in the monthly *"Federal Traffic News,"* which we will send to you on request.

Federal Motor Truck Company
35 Federal St. DETROIT, MICH.

FEDERAL

One to Five Ton Capacities



Longevity!—the power to *outlast*—is *inbuilt* in HALL TRUCKS. By a manufacturer who, for 45 years, has been specializing on *long life* construction.

Load them to the limit—send them over the uneven roads and impossible grades—put them to the gruelling jars and shocks that *undermine* most all other trucks—and your HALL Trucks will go *to and from* the job as unscathed *as a trench-crushing battle tank!* And it will keep on doing it for *years* with only *fractional depreciation.*

It's *right here* in paving, road, sewer and water works construction that HALL Trucks have established their reputation for *long life.* "For continual hard going nothing equals the HALL," says one who has used them *all.*

HALL *long life* specifications are built into every size of HALL Trucks. Compare the data and figures and *convince yourself.*

Haul it in a HALL.

THE LEWIS-HALL IRON WORKS

Manufacturers of the HALL Truck
(Established 1873)

Ferry Avenue and Grand Trunk Ry. **DETROIT, MICH.**

New York Distributors: R. D. King Motors Co., Inc., 9 Central Park West, New York City, Metropolitan Dealers.
New England Distributors: Hall Motor Truck Co. of N. E., 1123 Commonwealth Ave., Boston, Mass.
Guarantee Automobile Exchange, 629-31 N. Broad St., Philadelphia, Pa., Philadelphia Dealers.

EDITORIALS

Fundamental Changes Favorable to Construction

Many people outside the construction industries are beginning to realize that the present attitude toward public works cannot long continue. Those who ride in passenger automobiles, for example, are learning the results of postponing street repairs. In many localities roads and streets once a delight to the motorist are rapidly falling into such bad condition as to make their use more painful than pleasureable. The people are becoming somewhat restless because of this fact. Even the least discerning are heard to remark that many streets, if not soon repaired, will require reconstruction by next year. There is no question that hearty popular approval would be granted even now to a spirited revival of new road and street construction, to say nothing of the resumption of adequate maintenance of existing thoroughfares.

City officials seem somewhat less sure of the wisdom of postponing improvements until after the war than they have been in recent months. The end of the war seems far away, since it has become clear that a military decision must be reached before peace can come. The negotiated peace is not in favor. Germany must be defeated by force of arms and the fight will still be long, though the result no American for one moment doubts. Many officials who looked with favor on postponing improvements "for the present" are not willing to adopt this as a policy to be observed for a period that may last two or three years. They are beginning to count the cost, not of making improvements, but of the failure to make them at the right time. It is becoming better understood that such improvements as have normally been made in this country for many decades cannot be postponed indefinitely without serious economic loss and unnecessarily serious dislocation to the habits and customs of the people.

Those who favored curtailing construction because of present high costs are beginning to realize that these costs will remain as high after the war, perhaps for five or ten years, as they are now. The natural result of this conclusion, based on old experiences, recently rediscovered, will be a demand for the early resumption of construction work.

Generally speaking, people are beginning to realize, also, that not more than five or ten per cent. of our population is likely to become at all actively engaged in waging the war and not more than an equal number will be engaged in war work at home. All the rest of us, say at least eighty per cent. of the total population, must go on working from day to day, making a living and earning the money to buy Liberty Bonds and to subscribe for various other war purposes. It is only natural that people should want to do the kind of work they have always done and to live, so far as possible, as they have always lived. Under such circumstances they would do cheerfully the civilian's duty in the war, though it should last for twenty years. But if one line of business after another is made impossible, by government orders, winning the war is going to be made needlessly difficult for everybody.

The question is one of judgment, not one of narrow self-interest or of patriotism. We all approve of patriotism in the abstract, but have a right to scrutinize the measures advanced in its name. Every man has a right to speak up for his business. Engineers, contractors and others who have lived by serving the public in the design and construction of public works have every right to urge that the work they are best fitted to perform should now be resumed. The industrial mix-up, caused by our belated and feverish efforts to untangle our military arms and legs, is gradually straightening out, and there are now more and better reasons for resuming construction work than to continue the policy of postponement. Good observers have reached this conclusion who are above the suspicion of selfishness. When the Chamber of Commerce of the United States advocates the resumption of road building there is no longer an excuse for the failure of engineers and contractors to do the same. Letters should be written to local newspapers arguing for the resumption of construction; if this is done, public opinion will soon do the rest.

In a recent editorial, entitled "Crushing Business," the Western Banker and Financier said:

> If all business other than making of munitions of war, and food supplies and ships, is to cease, then it follows that only those who are employed in the occupations mentioned will have an income, and the rest of the population will have to depend upon them for a living. We are told, for instance, not to build any houses. What, may we ask, are the men who would be engaged in building to do for a living? They are not all needed in shipbuilding, because many of the occupations have no connection with ships; they are not needed in other directions, for the manufacture of war material, because that is being rushed to the limit. If the men were allowed to work at the occupations for which they are best fitted and could earn good wages, would they not be far better able to become bond buyers than if their occupation is taken from them?

These are pertinent questions. That such questions are being heard on every side is distinct cause for encouragement. Fundamental conditions are becoming more sound, and the prospect of an early return of something approximating normal business conditions is good.

Some of these fundamental changes in the official and popular points of view are directly favorable to the resumption of construction, while others are only indirectly so, since they are general, applying equally well to all legitimate business. Among the conditions beneficial to all business should be mentioned the better understanding recently reached between administration and big business leaders. The appointment of such men as Schwab, Ryan and Stettinius to important war posts is significant and has undoubtedly done much to stabilize business conditions. A settled policy in the war, "force without limit," has also greatly clarified the situation. Because of its definiteness this is an ideal working program. The period of errors and experiments is closing, and that of quantity production is beginning. That all business is due for early improvement seems most probable.

Standard Construction Methods

Much has been done by engineers to standardize specifications prepared to govern construction and also to standardize the broad essential features, and even the principal details, of engineering designs. Engineering literature is rich in matter relating to standard specifications and designs, but it is all too barren of matter relating to standard construction methods. Undoubtedly this is due, in part, to the fact that local conditions are supposed to govern the choice of construction methods. Within limits this is true, but the range of local conditions is not indefinite in extent, and the construction aspects of one job are very much like those of another involving the same materials of construction employed for the same ultimate purpose.

The meagerness of literature tending to standardize construction procedure is also due to the fact that contractors are disinclined to describe their work for the benefit of the other man. If contractors would publish descriptions of the construction plant and methods and the organization of forces they have found best suited to various types of construction work, we should soon have as much literature on standard construction methods as we now have on standard specifications and designs.

That contractors, with important exceptions, will do nothing of the kind is only too well understood. Admitting the need of more literature on construction methods, the engineer must supply it. A striking example of what engineers can do in this connection, if they will, is presented in this issue in the article on standard methods employed in building sewers in Chicago. That article will be read, and doubtless will be preserved for many years, by thousands of contractors and engineers. It is one of the best sewer construction articles ever published.

An interesting side light on the psychology of the contractor may be pointed out to the readers of Mr. Hudson's splendid article. It is likely that more than one contractor will at first feel, on reading the article, that his personal, private, individual stock in trade has been discovered and presented to the world. As a matter of fact, the standard methods described have been developed and uniformly employed by several of the leading Chicago sewer contractors over a period of years. Methods, plant and organization of forces are identical in the practice of these contractors.

This is often the case. Contractors in direct competition employ the same instrumentalities and each contractor lives in fear that his competitors will learn his methods (which they already know, of course). Thus he regards his procedure as his stock in trade and does not encourage publicity about his methods, plant and organization. The only men who could use this knowledge to his disadvantage already possess it, but his attitude denies the benefit of this knowledge to men who never compete with him—men in other parts of the country.

In those rare, futile moments when we indulge in longings wild and vain, we wish contractors would change their attitude toward publicity and help standardize construction methods. But we hope engineers will not wait for this wholesome and regenerating change to occur. Engineers will have to take the lead in this matter, and the sooner they do it the better for all concerned—including, of course, the contractors.

Stress the Word Engineering

In the name of this publication there are two words: Municipal and Engineering. Some see one word, some the other; many see both. Those who see but one word are implored to concentrate their vision on the word engineering, as this is an engineering, not a municipal, publication.

There is really no accounting for the tendency to read into a title what is not there and to read out of it what clearly is there. But much is to be gained by calling attention to the true meaning and proper interpretation of a title. In this case those who stress the word municipal and slur the word engineering get an entirely wrong idea of this publication and of the purpose and scope of its editorial contents.

We are moved to make these observations because just recently an article was tendered describing how the merchants of a Wisconsin town got together and decided to devote a certain percentage of their annual gross receipts to the purchase of Liberty Bonds, for contributions to the Y. M. C. A. and Red Cross funds, etc., and then to turn a deaf ear to all appeals. Now that might be called a municipal activity, but it certainly could not be called engineering. Another man thought to interest us with a letter telling of the building in one day of a Liberty Temple solely for war purposes. These things are of interest to all citizens, yes, but not to engineers as engineers. Such articles, therefore, do not belong in MUNICIPAL ENGINEERING. Why not submit them to The Journeyman Barber, The Lumberjacks' Gazette or The Butterine Vindicator? This is an engineering paper—get that point.

Do not draw inferences; analyze instead. Note the sub-title of this publication: The Design, Construction, Operation and Maintenance of All Public Works. Note the titles of its leading editorial sections: Pavement Design and Construction; Sewer Design and Construction; Water Works Design and Construction; Water Works Maintenance and Operation; Water Purification and Sewage Treatment; Drainage and Irrigation; Bridges and Buildings; Advance Information on Big Jobs, etc. No one is justified in concluding that a publication with such editorial contents is edited for any others than engineers, contractors and plant superintendents.

It naturally follows that those who really know this publication—that is, its regular readers—are: Engineers who draw plans and specifications and supervise construction work, contractors who build the works, and superintendents and managers who operate the works. This leaves out all such as are interested in civic betterment, community nursing, fly swatting, municipal markets, municipal Christmas trees, etc. Our waste circulation is, consequently, the absolute minimum. Subscriptions from those who haven't a legitimate, business interest in our technical editorial contents are declined. Offers of blocks of non-technical subscribers, with but a faint and fleeting interest in engineering matters, are most undesirable. The non-technical find nothing of interest in MUNICIPAL ENGINEERING, unless they expect to become students of technical matters. The spring crop of aldermen would better patronize the ball parks than subscribe for this publication, unless they intend to familiarize themselves with at least the broad aspects of engineering work in cities.

PAVEMENT DESIGN AND CONSTRUCTION

Asphaltic and Non-Asphaltic Road-Oil Specifications

By J. W. Howard, Consulting and Testing Engineer on Roads and Pavements, 1 Broadway, New York City

Many existing macadam, gravel, slag and similar roads, whether or not previously treated with road-oil impregnating them to a reasonable depth, can be repaired to grade with new material similar to the old road material, and then so treated with an application of road oil as to thus cheaply and quickly be put in good viable condition, especially in these war times, when entire reconstruction or resurfacing with more durable materials is not always possible from lack of funds.

Big Demand for Specifications

There being a large demand for standard specifications for asphaltic road oil and for non-asphaltic road oil, I have prepared the following two sets of specifications, based on long experience. Each of the several tests has a direct practical relation to the qualities which each kind of road oil should have to give the best possible results when properly applied in dry weather of a temperature above 70 degs. F. and when the road surface is free from moisture. Superfluous tests and alleged tests which are non-essential, peculiarities of single products or brands, are properly omitted, to combat commercial promotion and monopoly. The other requirements for preparation of the road surface and the application of oils and how to apply a thin layer of fine crushed stone screenings or coarse sand, especially over the asphaltic oil after its application and after several hours in warm weather or over night have been allowed for the oil to penetrate the road, are known to engineers familiar with road construction, and those other requirements are in the rest of the specifications for construction, etc.

These two sets of specifications for qualities of two types of road oils are each suited to many roads, but in many cases the asphaltic road oil is best and in the end more economical to be used, because of its more lasting qualities, and permit competition from the many road oils of good qualities of both types available throughout the United States and Canada.

General Requirements for All Road Oils

These specifications constitute a part of the contract.

The oil must be in all respects suitable for the purpose and subject to the approval of the engineer and must comply with the following requirements or tests:

The contractor must be properly equipped to apply the oil in accordance with the specifications, at the rate of at least 2,000 gals. per working day.

The contractor will apply the oil evenly with a vertical spray gravity sprinkler or with a pressure distributor or otherwise, as approved by the engineer.

A sample or samples of the oil must be submitted by each bidder with his bid, of the kind or kinds of oil he will use if the contract is awarded to him, and the oils subsequently used must conform to the quality required by these specifications. The samples must be of at least one pint each and delivered in cans (not glass) clearly marked with name and address of bidder, place and date of bidding.

Specification for Asphaltic Road Oil

1. Character of oil must be.....Asphaltic
2. Specific gravity at 60 degs. F.....At least 0.915
3. Per cent. of asphalt content, determined by the following test, shall be.....At least 50%

   The asphalt content shall be that portion of the oil which remains and has a consistency or penetration of 100 (1 centimeter) at 77 degs. F., with No. 2 standard needle, under 100 grams weight, in 5 seconds, after heating in air not to exceed 500 degs. F., until the asphalt residue of penetration 100 is obtained.
4. Flash point (open crucible).....At least 175 degs. F.
5. Solubility in carbon disulphide (moisture not exceeding 0.5% excluded), purity.....At least 99.5%
6. Solubility in 76 degs. Beaume naphtha...Not exceed 90%
7. Character of residue (freed from naphtha) after test 6 .....Must be sticky
8. Water present .....Not exceed 0.5%
9. Loss 20 grams (fresh sample) at 212 degs. F., 1 hour .....Not exceed 5%
10. Loss 20 grams (fresh sample) at 325 degs. F., 5 hours .....Not exceed 25%
11. Character of residue after test 10 must be..Soft and sticky

Specification for Non-Asphaltic Road Oil

1. Character of oil must be.....Non-asphaltic
2. Specific gravity at 60 degs. F.....At least 0.86
3. Viscosity (Engler 50 c.c.) at 100 degs. F..... .....Not faster than 25 secs.
4. Flash point (open crucible).....Not less than 300 degs. F.
5. Solubility in carbon disulphide (moisture excluded), purity .....At least 99.5%
6. Solubility in 76 degs. Beaume naphtha.....At least 99.5%
7. Character of residue (freed from naphtha) after test 6 .....Must be oily
8. Water present.....Not exceed 0.5%
9. Loss 20 grams (fresh sample) at 212 degs. F., 1 hour .....Not exceed 5%
10. Loss 20 grams (fresh sample) at 325 degs. F., 5 hours .....Not exceed 20%
11. Character of residue after test 10 must be.....Fluid

Note.—The engineer will cross out the specifications of the type of oil not required for each specific contract or work.

Data on California Asphalt Paving Work Performed with Portable Asphalt Plant

By T. E. Stanton, Assistant Division Engineer, California Highway Commission, Sacramento, Cal.

The data here given pertain to Topeka surfacing placed on the wooden trestles on the Upper Stockton road. The work was done in the winter of 1916, under very trying conditions, with a small, portable asphalt plant of the Bacon type.

In repairing the old stringers and floor an attempt was made to give a crown to the flooring by dapping the stringers. Owing to the condition of the old floor plank used, which was full thickness at the ends and worn thin in the middle, also to the fact that on some of the bridges, where, on account of using all old stringers, it was impracticable to give a crown to the wooden floor, the average thickness, instead of being 2 in. as intended, is practically 3 in., or 2⅞ in., to be exact. In some places the thickness is in excess of 4 in. in the center. Wherever this condition occurs (except on one bridge) coarse rock was used in the bottom course.

Except on one short bridge (the first laid), all pavement was laid in two courses, in order to prevent cracking on account of spring in the planks. It was also found necessary to

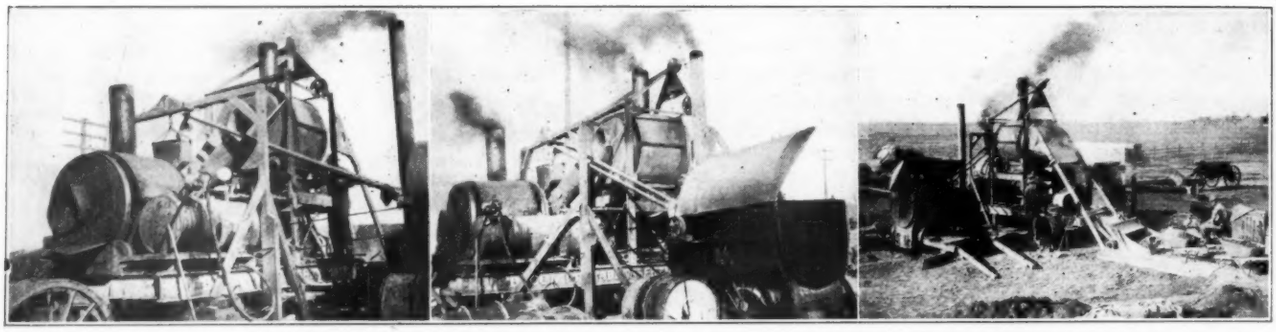
use a light 2½-ton roller instead of a 5-ton roller. The work was commenced November 19, 1915, and finished February 19, 1916, so that we were working throughout the winter rains, and were able to work only a little over one-half of the time.

The sand and screenings were continually soaked with water, and it frequently required from 15 to 20, and sometimes 25, minutes to dry out and heat up a batch to the required temperature.

The total number of 1,070-lb. batches turned out was 2,473; hours worked, 460¼, or 1 batch every 11.2 minutes on the average. The plant was therefore worked sufficient time to have turned out five or six times the amount actually laid within the period operated. With the exception of one burned-out firebox, which was repaired at a cost of about $30, the plant finished in good condition.

Bitumen	Spec. %	From Quantity Used	From Lab. Tests
	7.5—10	9.5	9.50
Mesh No. 200	8 —13	10.9	8.25
Mesh No. 80	14 —15	Sand	20.56
Mesh No. 40	17 —19	48.9	25.73
Mesh No. 10	5 —11	Screen	10.41
Mesh No. ¼	15 —25	30.7	13.44
Mesh No. ½	3 —10		12.11
		100.0	100.00

I am unable to account for the deficiency in dust (mesh No. 200) shown in the laboratory tests under that shown by the actual quantity bought and charged into the machine. From investigations the discrepancy seems to be due to the fact that part of the time the limedust was charged directly into the skip with the rock and sand, and passed through the drying drum with the wet materials. As the flame plays directly into this drum, it may be that during the long drying period part of the dust was blown out. There was no evidence of this around the plant in the way of dust deposit, however. It is possible that some change was effected in mixing the dust with the wet material, which balled up the dust and prevented thorough mixing, the lack of uniform mixing showing up in the tests. During the latter part of the work the dust was charged directly into the lower or mixing drum and tests showed better results.



VIEWS OF BACON PORTABLE ASPHALT PLANT USED IN PLACING TOPEKA SURFACING ON WOOD FLOORS OF CALIFORNIA HIGHWAY BRIDGES.

The accompanying pictures show the plant in operation, and also some views of the pavement.

During the cold weather none of the pavement laid cracked, and during the warm days following there was no appreciable softening. The only places where there was any early failure or cracking were on the first bridge laid, where some cracks occurred on account of laying in one course, and on one other bridge, where large loose splinters in the flooring were overlooked in four or five cases, causing the pavement to crack locally. These spots and splinters were removed and no further trouble occurred.

LAYING ASPHALT SURFACING ON WOOD FLOOR OF COSUMNES RIVER HIGHWAY BRIDGE, CALIFORNIA.

Antioch sand (48.9 per cent.), Natomas ⅛ to ½-in. screenings (30.7 per cent.), Standard Oil Company Calol asphaltum, 60 to 80 pen. (9.5 per cent.) and Pacific Portland Cement Company limedust (10.9 per cent.) were the constituents of the mixture.

Average of 49 laboratory tests show the following average percentage in the mixture:

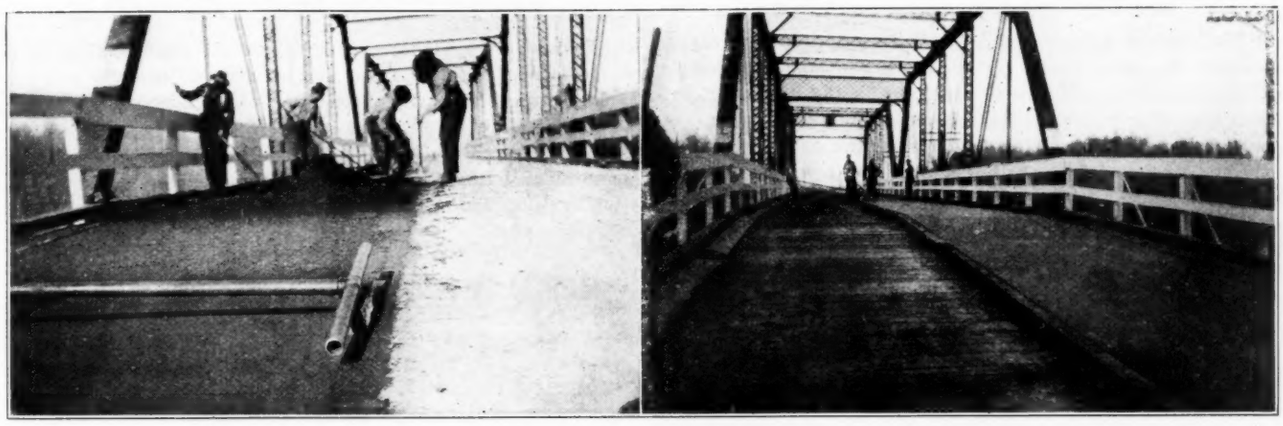
Summary of Work Done

Total length, 5,153 ft. (including approaches).
Surface area, 80,958 sq. ft.
Average thickness, 2⅞ ins.
Specific gravity obtained, 2.16 to 2.24 (depending on the extent of rolling).
Total weight materials used, 1,335.28 tons.
Total cost, $7,553.45, or $0.0934 per sq. ft. 2⅞ ins. thick, $0.8406 per sq. yd., $5.66 per ton asphalt mixture in place.

This cost includes materials, fuel, repairs, labor, superin-

tendence, transportation—in fact, every charge of any nature whatsoever against the work done from start to finish.

The original allowance for asphalt surfacing was $6,800. As there was a saving on the timber construction cost, however, and as there was also an allowance for contingencies, authority was secured to pave several bridges not originally included, so that the final cost of $7,553.45 for asphalt surfacing, against an original estimate of $6,800, represents the increased cost of materials for an average thickness of 2⅞ ins., instead of the 2 ins. of the estimate and the cost of paving the additional bridges.



LAYING ASPHALT SURFACING ON WOOD FLOOR OF COSUMNES RIVER HIGHWAY BRIDGE, CALIFORNIA.

Itemized Cost

Materials of Construction:

		Per ton Mixture in place	Per sq. ft.
Screenings, 409.2 tons	$ 314.95		
Sand, 652.75 tons	422.01		
Lime dust, 145.01 tons	698.20		
Asphalt pavement, 126.82)			
Paint coat 1.50)	1,240.85		
Distillate pt. coat, 850 gals.	68.00		
	$2,744.01	$2.055	$0.034

Operating Supplies:

Distillate for engine, 2,020 gals.	$ 161.60		
Fuel oil—plant, 131.14 bbls.	156.17		
Gasoline, 569 gals.	84.03		
Coal, 1½ tons	15.30		
Kerosene, 530 gals.	45.05		
	$ 462.15	$0.346	$0.0057

Repairs to Plant:

Chain renewals	$ 31.98		
Sprocket, 14½ in.	3.80		
Sprocket, 6¾ in.	1.70		
Babbetting bear. on compressor	3.08		
Renewing bear. on compressor	3.75		
Grease cups	1.05		
	$ 45.36	$0.034	$0.0006

Rentals:

Roller	$ 250.00		
Wagons	123.33		
Superintendent's auto	224.90		
	$ 598.23	$0.448	$0.0074

Labor:

Prelimin'y handling of materials	$ 312.74		
Paint coat	206.12		
Mixing (inc. setting plant)	1,041.76		
Hauling	547.81		
Laying	1,061.52		
Superintendent	340.00		
Timekeeper	194.75		
	$3,703.70	$2.777	$0.0457
Totals	$7,553.45	$5.66	$0.0934

Equipment for Asphalt Plant

Asphalt plant	$2,368.20
400 gal. heating kettle	299.75
7 beam charging scales	106.25
Dial scales	10.20
Rotary pump	15.15
Two thermometers	6.01
Asphalt bucket	15.35
Piping for asphalt	25.56
Mounting asphalt pump	3.78
Steel plates on sides of drum	16.64
Extensions to fire box	12.00
Belt for pump	3.52
Two oil cans	5.05
Oil burners	32.25
Sprocket and chains	37.48
	$2,957.79

Additional Tools and Equipment Purchased

Tool heater	$ 50.00
65 gal. kettle for heating	108.76
Asphalt for paint coat	.....
Hot hand roller and 35 lb. iron	40.50
16 shovels, 6 smelter brooms, 4 wheelbarrows, 3 wrenches, etc.	56.19
Three mattocks	3.38
Four tampers	8.55
65 lb. smoothing iron	6.00
Two 4 gal. pouring cans	9.75
Miscellaneous hardware	18.94
	$ 302.07
Total cost of asphalt outfit	$3,259.86

This cost of outfit is exclusive of rollers and wagons owned or rented by the state.

The Plant and Its Operation

Now as regards the plant and method of working: The mixer was made by the E. R. Bacon Company on order of the state, based on blueprints showing proposed design. The basis was the "rapid heated mixer," a single drum mixer with flame shooting directly into the drum and another flame into a firebox beneath the drum. With the single drum mixer the operator was depended upon to turn off the direct fire when charging the asphalt in order to prevent burning. This precaution was frequently overlooked, with the result that a number of failures had been turned out by the small portable mixers.

In order to remove any possibility of burning the asphalt, also with the idea in view of installing a loading skip which the standard "Rapid" mixer did not have, and of securing a greater output than could be secured with a single drum, the plant as purchased by the state was designed.

A wooden platform was built around the skip as a charging platform. A Fairbanks-Morse 7-beam charging scale was placed at the end of this platform and the material wheeled from the stock piles across the scale onto the charging platform.

The first method used was to dump one sack of limedust directly into the skip, a fractional bag of dust sufficient to make up the amount required per batch being dumped onto and weighed on one of the wheelbarrows. It was found necessary, however, to modify this method, on account of the fact that dumping the limedust into the top drum at the beginning apparently (according to test, but not to the eye) allowed a large percentage to be blown out of the drum during the time required to bring the batch up to proper temperature. The later method is necessary during the period of the year when a long time is required to dry out the screenings and sand. In the summer time, when it will require but two or three

minutes to heat a batch, the limedust can be introduced from the start.

Both flames are used in the upper drum to dry the material, but only one flame is used in the lower drum, that in the firebox, so that there is no danger of burning the asphalt by direct contact. When the aggregate is heated to proper temperature in the upper drum, it is turned into the lower drum, the asphalt and limedust being introduced simultaneously and the whole mixed until the next batch is about ready in the upper drum, at which time the mixture is dumped.

A dial scale is hung on an A-frame directly over the charging end of the lower drum. On this scale is hung the asphalt bucket, which holds 100 lbs. of asphalt. In the bottom of the bucket is a pipe outlet with a quick-opening gate valve. A small rotary pump is mounted inside of the asphalt heating kettle and operated by a belt from the shaft which operates the air compressor. The asphalt is pumped through a 2-in. pipe to a point just above the charging bucket and back through a by-pass into the kettle. Both pipes are shown in the accompanying pictures. When time to charge, a gate valve on a pipe charging into the bucket is opened and a gate valve on the by-pass closed. The discharge is accomplished by elevating the frame a little and backing a wagon up to the discharging spout. This looks a little awkward until tried. It has, however, been found very practicable.

All main parts of the plant are standard. The drums are standard "rapid-heated" drums; the hoist for the skip is from the Foote mixer; the compressor is a standard Rix compressor and the engine a 20-h.p. engine.

An Argument for Changing Common Method of Financing Pavement Construction and Renewals

By Charles A. Mullen, Director of Paving Department, Milton Hersey Co. Ltd., Consulting Engineers, Inspectors, Industrial Chemists, Montreal, Canada

A recent article by George C. Warren of Boston, Mass., again opens the controversial subject of: How shall we pay for our pavements? One possibility, not dealt with by Mr. Warren, is, charging them to the public through a wheel tax levied by the city, county or state. The writer would like to see this idea fully exploited; or, to learn where it is in vogue and how it is working, if at all.

Why do we build roads—and pave them? For wheels. No other reason. Were it not for vehicular traffic, other than bicycles and baby carriages, sidewalks and footpaths alone would serve our purpose. And, since we build the pavements for the wheels, wouldn't it be logical to pay for them through the wheels?

It has always seemed to the writer that a tax should be collected through a logical channel. At present, we are fooling ourselves very badly as to the cost of highway transportation. A railway must maintain its roadbed, and collect the cost thereof in its freight charges and passenger fares; while an autobus line, delivery wagon or auto truck, or even a passenger automobile, does not pay for its roadbed, and the expense thereof is not figured into its cost of operation.

A Step in the Right Direction

It is true that some states are taxing automobiles and using the proceeds for road maintenance. This is a step in the right direction; but, why not carry the principle to its logical conclusion, by securing all the money for road building and maintenance through a wheel or vehicle tax? If roads are for vehicles and vehicles alone, why should the general city tax, or the abutting property, pay for them, instead of the owners of the vehicles to whom the wheel tax would be charged? They, in turn, would charge it into the cost of their services to the community, so that, finally, it would rest, as always, upon the ultimate consumer—but, through the logical and proper channel instead of in the present unsatisfactory way.

Montreal as a Bad Example

Illogical procedure may usually be depended upon to produce illogical results. In the city of Montreal, where the writer now spends most of his time, and which pays for both its pavement construction and pavement maintenance out of the general city fund, the illogical results have fully materialized. On the whole, we probably have the worst paved streets in North America.

Because of a stringency in municipal finance, charged by some to war conditions, but due much more directly to purely local causes, quite painful for a citizen of Montreal to mention, the "City Fathers" thought it wise to neglect the street pavements. Thereby they avoided spending some money from the general city fund for those particular years when these particular "City Fathers" were appealing to the citizens for their suffrage, and they were happy.

Money was saved to the particular general city fund; but, in doing so, they wasted a lot of money for the community. After a few years of this kind of "saving," the streets of Montreal are so bad that they can be traversed neither with pleasure nor in safety. Trucking firms were, even last year, threatening to sue the city for damages, because of the excess wear and tear on equipment, and the greater expense of smaller loads made necessary through the ill repair of the pavements.

Now what the general city fund "saved" in dollars and cents was paid out, many times over, in equally good dollars and cents, by the vehicle owners using the streets of the city. They paid in repairs to wagons and automobiles, and in excess horse power—both in the nature of gasoline and oil, and of the old animal flesh-and-blood kind—required to move a given tonnage between given points. They paid heavily; and they kicked to the "City Fathers," to no purpose.

Were the City of Montreal paying for its pavement construction and maintenance by a wheel or vehicle tax, this condition would not exist very long. The vehicle owners would not be slow to realize that they could get the same results at less cost by paying their money into a proper tax fund to build and maintain pavements, rather than by paying it to the wagonsmiths, the garages, the horse dealers, and in excess labor costs to men who are swearing at the discomfort to themselves growing out of the unkept street surfaces.

Answers to Objections to Wheel Tax

Some may object to the wheel tax, as a means of paying for road service, on the ground that it too closely resembles the old toll roads system. To such, it can be said that there were two great objections to the collection of tolls; first, too much of the amount of the tax was spent in the collecting thereof, and second, the toll roads were privately instead of publicly owned. Of these objections, to the writer, the last only seems fundamental; the first is a matter of practical application that is overcome by the wheel tax.

Another objection that might be raised, is, that we are getting away from free public roads. But nothing is free; we are paying for them now, only by a different and less satisfactory method. Nothing that is the result of labor can ever be free. Natural resources may be, but not manufactured products, such as roads. Someone must always pay; so, why not have the burden fall equitably upon the road users through a wheel or vehicle tax?

The writer is not ignoring the fact that so radical a change in the method of paying for our pavements would meet with a lot of opposition from the statu quo. Neither does he claim to have suggested anything new; for the plan was, he is quite sure, advanced by others long ago. What he does suggest is that we really begin to think about doing something along these lines. It is a long way to Tipperary, but it is probably

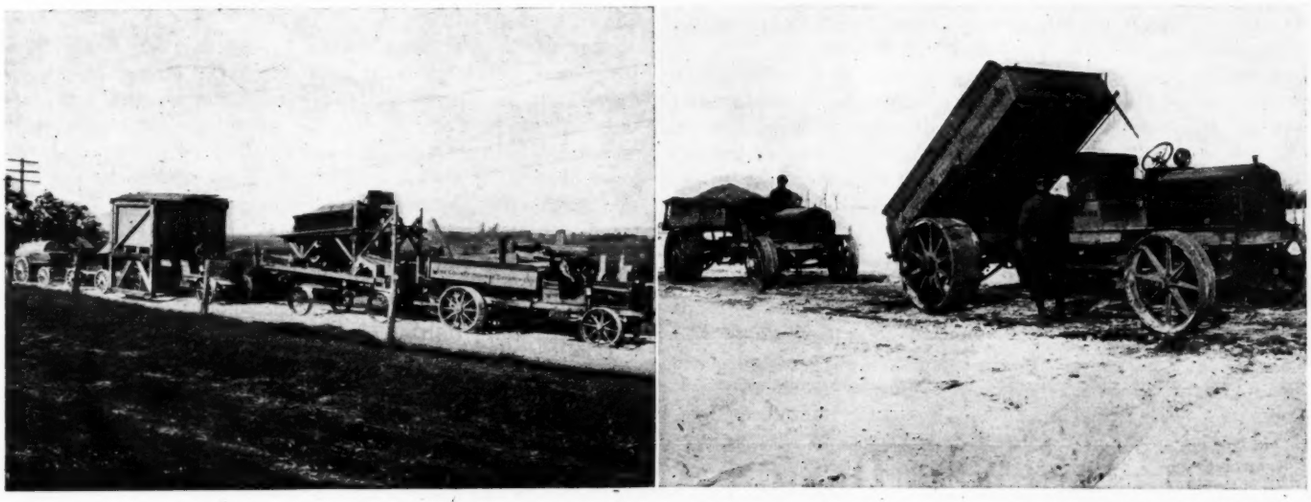
an even longer journey to a satisfactory method of taxation to pay for road building and paving. Let's hear what the single taxers, and others, have to say about it.

Methods and Cost of Building Gravel Roads in Kane County, Illinois

By Geo. N. Lamb, Superintendent of Highways, Kane County, Geneva, Ill.

In Kane County, Illinois, County aid work consists of the construction of the township roads by the use of the county's outfits of machinery. Three such outfits of machinery are now maintained. Outfit No. 1, here illustrated, is a portable plant for screening and crushing gravel, with motor trucks for the hauling, spreading and rolling.

Outfits No. 2 and 3 are employed in the construction of earth roads, or in the preparation of road beds for the application of gravel or crushed stone. Each of the grading outfits consists of 40 H.. P. gasoline tractor, heavy grader, scarifier and drags.



VIEWS OF MODERN ROAD BUILDING MACHINERY OWNED BY KANE COUNTY, ILL., AS OPERATED ON GRAVEL ROAD CONSTRUCTION.

Left: Road Building Outfit No. 1 on the Move. Right: Road Building Trucks.

Rebuilding Old Gravel Roads

Many of our old gravel roadbeds formerly built for team traffic only, are so narrow or crooked and so poorly built that they have to be entirely torn up and re-shaped before fresh gravel is applied. To do this work properly often necessitates the destroying or covering up of all the gravel or other surface applied in former years. It is often a serious question whether to sacrifice all previous expenditures and rebuild the road or to practice false economy by tolerating the defects and resurfacing the road as it stands. To practice the former method means a greater present cost, but an end to future wasteful expenditures; the latter means a lower present cost with a continuance of make-shift repairs, until some future time when reconstruction will have to be accomplished. Heretofore in the construction of roads, too little attention has been paid to the proper shaping, alignment, grade reduction and drainage and very few of the old roads throughout the county are in condition to warrant the application of a permanent surface until they have been entirely rebuilt.

Use of Modern Road Building Machinery

Before any gravel or other surfacing material is applied the roadbed itself should be permanently improved. With this end in view Kane County is now equipped with modern road building machinery suitable for this class of work. Considerable work has been done by means of this road building machinery which otherwise could not have been accomplished. Gravel crushed and screened to the proper size has been placed on roads at a moderate cost at distances from the pit, which under other conditions would have made the cost even of an inferior material nearly if not quite prohibitive.

Early in the spring of 1917 we foresaw that the amount of work planned for Outfit No. 1 was much greater than could be accomplished in one season of ordinary work. Accordingly electric lights were installed, to permit the operation of the plant at night. Two complete crews were employed and the machinery was operated 18 hours per day, the men changing shifts at noon. While this plan has practically doubled the working capacity of the machinery, as well as the amount of gravel crushed and hauled, we still were not able to do all the work requested by the various townships.

The work done by this outfit for the year ending December 1, 1917, comprised: 9,817 cu. yds. of gravel crushed, hauled, spread and rolled; the average length of haul (1 way) was 2.9 miles; the extreme length of haul (1 way) ranged from 3 to 6.3 miles for the 7 townships; the total work done in ton-miles was 42,356.

Cost Data

The cost of producing and delivering road material by this outfit varies considerably, depending on the road and weather conditions as well as on the accessibility of the gravel pit. If the gravel pit is situated near the roadside, a hard rain will delay us only a few hours at the most; but if the pit is located far from the road, the mud in the field is apt to cause a delay of several days.

We give below the cost data in one township (Blackberry Township) where the work was done under average summer weather conditions. In this township the average length of haul was 1.9 miles (1 way) and the extreme length of haul (1 way) was 4.2 miles.

Road No. 11—Spreading, 4.0 cts. per cu. yd.; hauling, 54.8 cts. per cu. yd.; hauling, 18.3 cts. per yd.-mile; crushing and loading, 53.4 cts. per cu. yd.; per yard delivered on road, $1.12. 315 cu. yds. of gravel; Sept. 17-20, 1917; length improved, 0.8 miles; grading road No. 11, outfit No. 3, $113.74.

Road No. 15—Spreading, 2.1 cts. per cu. yd.; hauling, 27.0 cts. per cu. yd.; hauling, 27.6 cts. per yd.-mile; crushing and loading, 41.0 cts. per cu. yd.; per yard delivered on road, 78.0 cts. 336 cu. yds. of gravel; August 10, 16, 20-23, 1917; length improved, 0.7 miles; grading road No. 15, outfit No. 3, $53.11.

Road No. 20—Spreading, 3.9 cts. per cu. yd.; hauling, 50.9 cts. per cu. yd.; hauling, 20.6 cts. per yd.-mile; crushing and

loading, 50.7 cts. per cu. yd.; per yard delivered on road, $1.05. 205 cu. yds. of gravel; August 24-27 inclusive, 1917; length improved, 0.5 miles; grading road No. 20, outfit No. 3, $30.94.

Road No. 21—Spreading, 2.8 cts. per cu. yd.; hauling, 25.4 cts. per cu. yd.; hauling, 25.7 cts. per yd.-mile; crushing and loading, 29.7 cts. per cu. yd.; per yard delivered on road, 57.9 cts. 163 cu. yds. of gravel; August 13 and 14, 1917; length improved, 0.3 miles; grading road No. 21, outfit No. 3, $30.04.

Road No. 22—Spreading, 2.7 cts. per cu. yd.; hauling, 36.6 cts. per cu. yd.; hauling, 20.9 cts. per yd.-mile; crushing and loading, 42.0 cts. per cu. yd.; miscellaneous, 1.4 cts. per cu. yd.; per yard delivered on road, 82.7 cts. 1,169 cu. yds. of gravel; August 16-24, 27, 29, 30 and 31, Sept. 1 and 12, 1917; length improved, 2.4 miles; grading road No. 22, outfit No. 3, $136.57 (1.6 mi. only).

Road No. 23—Spreading, 2.0 cts. per cu. yd.; hauling, 26.9 cts. per cu. yd.; hauling, 45.0 cts. per yd.-mile; crushing and loading, 36.6 cts. per cu. yd.; per yard delivered on road, 65.5 cts. 150 cu. yds. of gravel; Aug. 15, 1917; length improved, 0.4 miles; grading road No. 23, outfit No. 3, $69.20.

Road No. 24—Spreading, 2.5 cts. per cu. yd.; hauling, 62.8 cts. per cu. yd.; hauling, 19.4 cts. per yd.-mile; crushing and loading, 24.5 cts. per cu. yd.; miscellaneous, 24.5 cts. per cu. yd.; per yard delivered on road, $1.38. 300 cu. yds. of gravel; Aug. 4-7, Sept. 10 and 11, 1917; length improved, 0.2 miles; grading road No. 24, outfit No. 3, $47.99.

Use of Road Tar Growing

The war has changed a plan of building roads. The roads connecting cities have been subjected to a test which had never been applied previous to the commencement of hostilities. Thousands of heavy trucks, each with its capacity load, have traveled over our highways between business centers. Trains of army trucks have hauled men and supplies between mobilization camps throughout the country. Due to the tie-up in railroad transportation facilities and various embargoes in some sections of the country, commercial trucks have been placed in use to make regular runs between different cities. As an example, 640 trucks make 7,200 trips between Philadelphia and New York each week, all over the same highway.

This increased valume of heavy vehicles traveling over the country roads has in many cases shown the inadequacy of the macadam type of road for very heavy loads. The macadam road is excellent for travel purposes if kept in repair. Due to the shortage of labor, country and state highway departments have been unable to cope with the situation, and as a result ruts formed in the surface of the macadam road, and not being in many cases repaired, have grown worse and the roads are almost beyond repair.

The sections of road having a road tar base—that is, a stone road cemented with a prepared tar binder and stone dust—have in every case proved superior to the macadam type. This class of road has the advantage of being able to withstand heavy traffic without forming ruts. There is no loose dust to be drawn up from the road surface by the suction of the tires, as happens in a macadam road. The main traveled highways of the nation that are paved with this tar cemented stone are bearing the burden of increased traffic without weakening, and it is safe to say that in the future probably all roads that have a large amount of travel will be paved with the bitulithic preparation instead of macadam.

SEWER DESIGN AND CONSTRUCTION

Organization of Forces and Plant and Methods Employed in Construction of Sewers in Chicago

By Herbert E. Hudson, Division Engineer, Board of Local Improvements, City Hall, Chicago

The development and extension of the sewerage system in a great city like Chicago, has brought about many interesting features along the lines of efficiency in construction work and field organization.

Standardization of Organizations

In a field like that offered by Chicago, where 60 to 80 miles of sewer are constructed each year, there is a great opportunity for standardization of organizations, particularly among those contractors who handle the same general classes of work year after year.

Records of cost prices covering a period from 1907 up to the beginning of the war, show that there was a steady decrease in the cost of sewer construction in Chicago. The cost of labor and material during that time was on the steady increase, and the analysis of the cost figures shows that the lower cost can be attributed only to two factors. The first and foremost factor is undoubtedly the advent of excavating machinery into this field of construction. Coupled with the use of machinery there came the second factor—careful study and perfection of organizations.

Influence of Excavating Machinery on Labor

The use of excavating machinery, which permits a more rapid rate of construction, has required that contractors select workmen who are particularly adapted to certain kinds of work and who have proved their skill in performing individual operations. The skillful manner in which some of these workmen perform their work is almost beyond belief. For instance, certain workmen engaged in trimming the bottom of the excavation on which the pipe is graded will perform this duty hour after hour with variations that do not exceed ¼ in. to ½ in. The city inspectors are required to guage each pipe to a line, and the taking up and relaying of any one pipe occasions a loss of time. It therefore behooves the workman who is striving to keep up with the excavating machine to exercise great care in his work. Certain classes of workmen in Chicago pride themselves on their skill in this work and are retained by the contractors year after year.

The economy of machine work depends very largely upon the continuous operation of the machines, and thus it becomes necessary for the contractor to develop his organization in such a way that the rate of construction can be balanced with the rate of excavation. The constant danger of interruption to this plan has been the likelihood or danger of breakdown in machinery, and while this difficulty was very serious during the earlier experimental stages of machine work it has been greatly reduced in later years.

Classes of Construction

In Chicago, there has been a natural division of sewer work into classes. The first class of construction, we may say, is the sewer work constructed in machine excavation. This class further subdivides itself into the small and large sewers.

The design of excavating machinery and the development of its use in field construction has drawn a natural line of

division between the large and small sewers somewhere between 3 ft. and 4 ft. in diameter . Sewers ranging in size from 3 ft. down are classed as small sewers, and those ranging from 4 ft. up are classed as large sewers.

Small Sewers

Machines which handle the small sizes of sewers are usually developed for speed of travel for the narrower trenches, and their efficiency has been worked out on this class of work. Actual yardage of excavated material is large, but it is excavated in small units and at a great speed. These machines are often equipped with changeable speeds and various sized buckets or other arrangement for trench width such as will enable them to dig trenches for sewers larger than those indicated in the general classification as small. For instance, there are three types of machines of the endless belt type capable of excavating for small pipe sewers at great speed that can be geared down and made to dig trenches for sewers up to 5 ft. in diameter. The contractors in general, however, seem to draw the dividing line about where it has been indicated, and show considerable hesitation in overstepping the limits indicated. Other contractors have tried the use of larger machines capable of excavating for the larger size sewers equipped with special fittings for digging small pipe sewers. The loss in efficiency has been much more apparent in these cases. While it may be possible to equip the machines used on small work so that they may operate with a fair degree of economy on some of the larger sizes, the reverse condition is not so true, and usually little economy has been accomplished in the use of heavy machinery for lighter work.

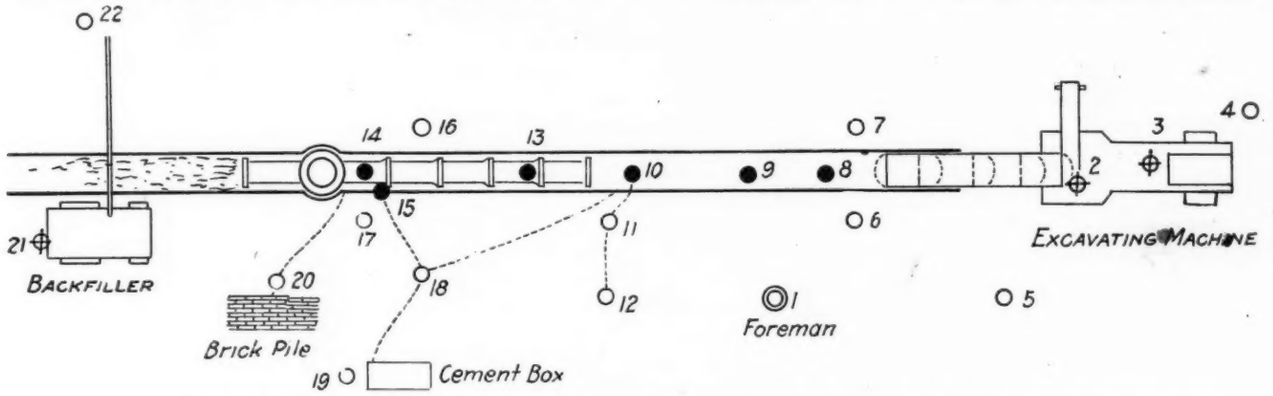


FIG. 1—CHICAGO ORGANIZATION FOR CONSTRUCTING SMALL SEWERS WITH POWER EXCAVATORS AND BACKFILLERS.

1, Foreman. EXCAVATING ORGANIZATION: 2, Operator; 3, Fireman; 4, Laborer; 5, Coal Passer; 6 and 7, Bracing Tenders; 8, Bottom Bracer; 9, Bottom Man. CONSTRUCTING ORGANIZATION: 10, Grader; 11, Lowering Pipe; 12, Pipe Passer; 13 and 14, Brick Layers; 15, Brick Layer's Tender; 16, Laborer; 17, Brick Tosser; 18, Cement Carrier; 19, Cement Mixer; 20, Brick Wheeler. BACKFILLING ORGANIZATION: 21, Backfiller Operator; 22, Laborer.

Hand Excavation and Miscellaneous Class

In addition to the work constructed in machine excavation there are two other classes of work, namely, those constructed in hand excavation and a miscellaneous class.

Hand excavation on certain classes of work may be due to special conditions, such as rock, running sand, etc. The third class, called "miscellaneous," includes such work as digging up and rebuilding existing sewers, or the construction of new relief sewers in closely built-up communities. This last class usually requires special machinery for excavation, or possibly hand excavation under particularly difficult conditions.

Development of Excavating Machinery.

Going back to the classifications of work done in machine excavation, we find that the greatest progress has been made in the development of machinery for this kind of work on the so-called smaller sizes. During the last ten years approximately six different types of machines with which the writer has been familiar have been developed and tried out in the Chicago field. Two of these machines have survived as being the most efficient and satisfactory for this work. Each of these machines has gone through a process of evolution so that one

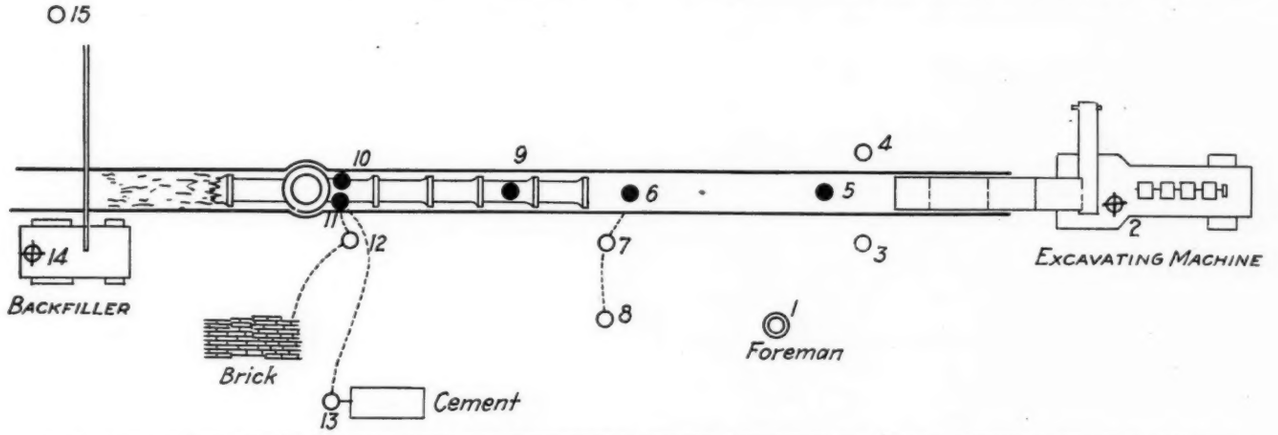


FIG. 2—CHICAGO ORGANIZATION FOR CONSTRUCTING SHORT LENGTHS OF SMALL SEWERS WITH GASOLINE DITCHER AND BACKFILLER.

1, Foreman. EXCAVATING ORGANIZATION: 2, Operator; 3 and 4, Bracing Tender; 5, Bracer and Bottom Man; CONSTRUCTING ORGANIZATION: 6, Grader; 7, Lowering Pipe; 8, Pipe Passer; 9 and 10, Brick Layers; 11, Brick Layer's Tender; 12, Brick Tosser and Carrier; 13, Cement Mixer and Carrier. BACKFILLING ORGANIZATION: 14, Backfiller Operator; 15, Laborer.

would scarcely recognize the present type of machine as a development from its original form. Some parts have been made stronger, some of the methods of handling excavated material have been changed, and the tendency on the whole has been toward a more rapid excavation. This tendency toward speed in excavation has necessitated the contractors' increasing the efficiency of the organization which is to follow behind the excavating machine.

Organization of Forces

The organization of the field force surrounding one of these machines may be divided into three separate groups: the excavating organization, the constructing organization, and the backfilling organization.

The constructing organization may be further subdivided into that which constructs the sewer proper and that which constructs the various structures connected with the sewer, such as manholes and catchbasins. The organization given below is a type organization such as might be found following a machine excavation for a small sewer.

Excavating Organization

In the excavating organization, if the machine is operated by steam, we find an operator and fireman on the machine. There is another man carrying coal and levelling the ground ahead of the machine. Immediately behind the machine there consists of one bricklayer, one bricklayer's tender, one brick tosser, one brick carrier, one cement carrier, and perhaps an odd laborer. In this group then there are six men.

As an added number to these two constructing groups there will be the cement mixer and another odd laborer, all under the supervision of a competent foreman.

Scheme for Relieving Tired Men

When ground conditions are favorable and the average excavation does not exceed 8 ft. or 9 ft. deep, these excavating machines are capable of digging from 1200 to 1600 ft. of trench in a working day of 8 hours.

The handling of the material for the construction of this kind of sewer becomes a very great problem, and it is frequently necessary to make changes in the men so that the burden of the hard and fast labor will not fall too long upon the shoulders of any one or two men. When the contractor has reason to expect that he is going to make this rapid progress, or when the size of the sewer becomes 20 in. in diameter or greater, he usually supplies from 3 to 6 additional laborers who are kept busy at odd work around the machine and are kept as alternatives for replacing the men in the regular organization when they become tired.

Backfilling Organization

The backfilling on such a job is usually done by a type of

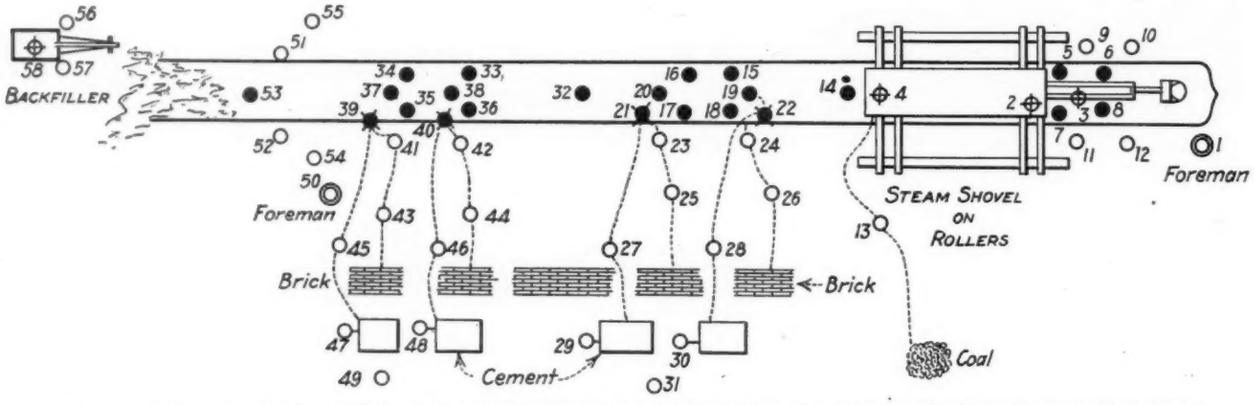


FIG. 3—CHICAGO ORGANIZATION FOR CONSTRUCTING LARGE SEWERS WITH USE OF HEAVY MACHINERY.

1, Foreman. ON MACHINE: 2, Engineer; 3, Craneman; 4, Fireman. EXCAVATING ORGANIZATION: 5, 6, 7 and 8, Bottom Trimmers and Bracers; 9, 10, 11 and 12, Sheeting Passer and Roller Tender; 13, Coal Passer; 14, Bottom Trimmer; BOTTOM OR INVERT ORGANIZATION: 15, 16, 17 and 18, Brick Layers; 19 and 20, Brick Layers' Tenders; 21 and 22, Scaffold Men; 23 and 24, Brick Tossers; 25 and 26, Brick Wheelers; 27 and 28, Cement Carriers; 29 and 30, Cement Mixers; 31, Laborer; 32, Form or "Center" Setter. ARCH ORGANIZATION: 33, 34, 35 and 36, Brick Layers; 37 and 38, Brick Layers' Tenders; 39 and 40, Scaffold Men; 41 and 42, Brick Tossers; 43 and 44, Brick Wheelers; 45 and 46, Cement Carriers; 47 and 48, Cement Mixers; 49, Laborer; 50, Foreman in Charge Constructing Organization; 51, 52 and 53, Laborers Pulling Sheeting; 54 and 55, Laborers Carrying Sheeting. BACKFILLING ORGANIZATION: 56 and 57, Laborers; 58, Operator on Backfilling Machine.

are two men engaged in handing down sheeting and steadying it until one of the bottom men has placed the cross bars between the upright sheeting. Following the excavating machine in the bottom of the trench there are usually two men; one man engaged in throwing the loose excavated material ahead to the buckets as they pass around and placing sheeting and braces, and the other man engaged in trimming up and smoothing the bottom of the trench so that the pipe laying may follow rapidly. This gives a total of seven men in this group.

Constructing Organization

Following this group comes the constructing organization laying the sewer proper. Here we have one man in the bottom laying the pipe, and under Chicago conditions we have a bricklayer sealing off the pipe and junctions as rapidly as they are laid. On the surface of the ground there is one man passing pipe down to the pipelayer and one man engaged in carrying pipe from the side of the street to the trench. In this portion of the constructing crew there are four men.

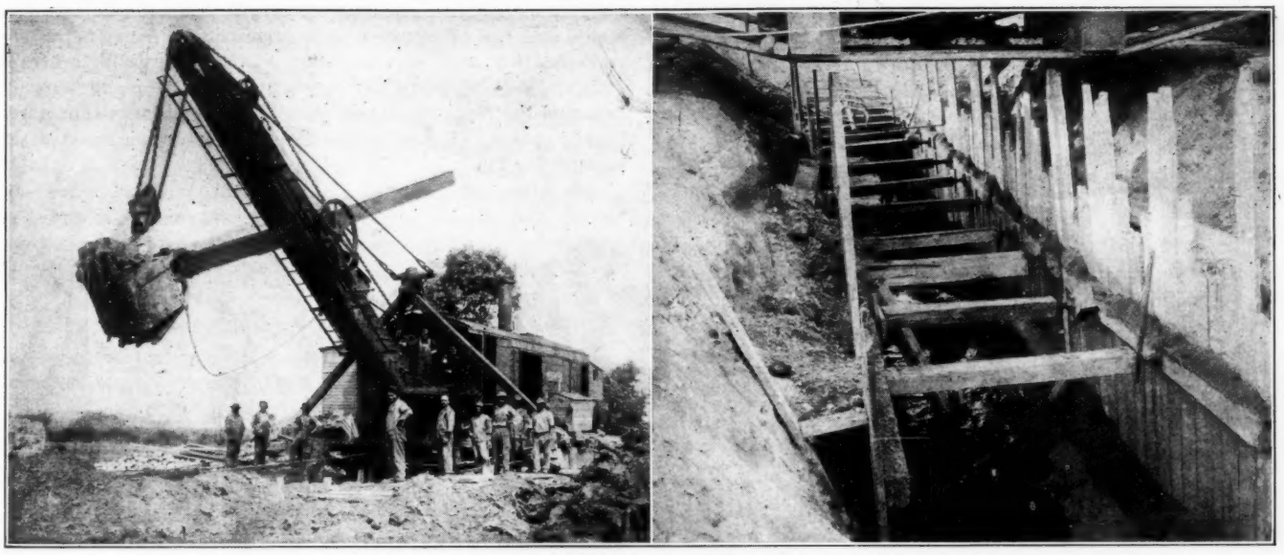
In addition to this construction group there is a force engaged in building manholes and catchbasins. This force usually

backfilling machine, several of which have been developed to meet the demand created by the perfecting of the excavating machinery. One of the most popular among the gasoline driven machines is shown herewith. It is the Parson's trench filler. This machine requires one man to operate the machine and one man to guide and steady the bucket or bucket board. Several attempts have been made to do away with the man guiding the bucket or bucket board, but up to the present time no type of machine has been developed which completely eliminates this man. This is particularly true of the lighter machines used for this work. There have been one or two heavier machines developed carrying a heavier bucket board, which apparently needed only occasional steadying by hand, but these machines have been so much heavier and more cumbersome that the rate of progress they have shown has not compared favorably with the lighter machines requiring the additional man. These machines have not been capable of backfilling each day all of the trench excavated by the excavating machine, but, as there are usually delays of one kind or another arising on this kind of work, the machines are on the whole

able to maintain an average rate of backfilling about equivalent to the average rate of excavation.

Including the night watchman, the total organization for such work will usually number 22 to 28 men. The actual number employed may be as low as 22 when skilled and well-trained men are employed. There are usually some new men in the group and this will necessitate additional men up to the number indicated. See Figure 1.

The constructing organization is about the same as that indicated in the former organization, except that there is an opportunity to do away with the man carrying pipe from the side of the street. If the material is properly distributed along the line of the work, there is also an opportunity to do away with the man who carries brick. Such an organization is indicated in Figure 2, and carries a total of 14 workmen under the direction of one foreman.



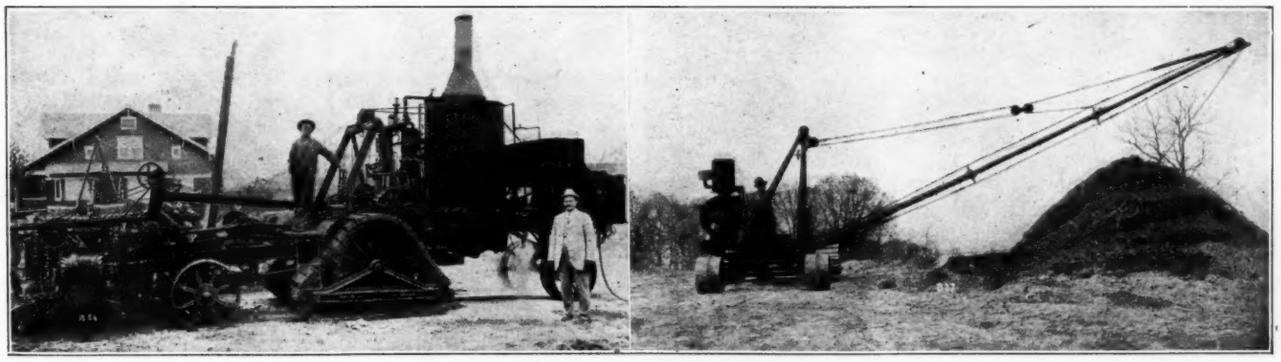
EXCAVATING FOR LARGE SEWERS IN CHICAGO WITH 70-TON MARION STEAM SHOVEL.
Note Method of Supporting Shovel Over Trench on Truss and Rollers. Lower View Shows Trench in Sand Under Shovel.

Standard Reduced Form of Organization

The general organization indicated for the smaller sewers is that which would be used by a contractor equipped with a machine capable of performing the amount of work indicated for the 8-hour day. There are several contractors in Chicago equipped with excavating machines for this class of work, whose machines are not capable of the rate of excavation indicated in the foregoing organization. In order to balance their efficiency and costs so that they may compete with the others, it becomes necessary for them to eliminate some of the workmen.

A gasoline driven machine eliminates the firemen. It also eliminates the necessity of carrying coal or maintaining a water line. The extra duties of this coal passer are usually performed by the man handling sheeting or by the odd laborers. As the speed is not so great, there is only one man in the bottom behind the machine who does all the bracing and trimming. The organization used for digging is therefore reduced to four men instead of seven.

Such an organization is used for the construction of small lengths of work, and it is very often possible for the contractor to do away with one bricklayer in such an organization, allowing the pipe to be laid and sealed by the bricklayer, and then during the occasional delays having the bricklayer go back and construct necessary manholes, allowing the catchbasins to be left until the sewer proper has been constructed. He can then so arrange his organization that a portion of the workmen are excavating for catchbasins while the bricklayer is building them.



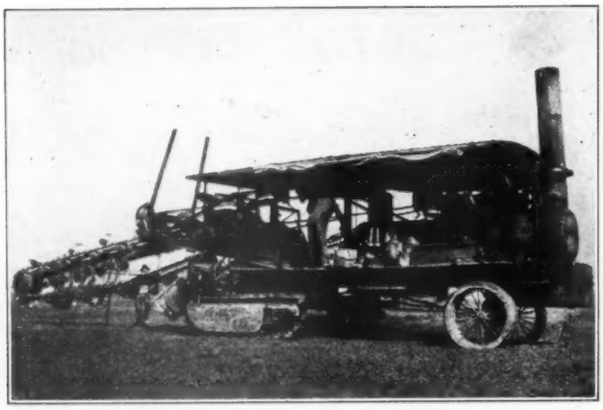
TYPES OF SEWER EXCAVATING AND BACKFILLING MACHINERY SUCCESSFULLY EMPLOYED BY CHICAGO CONTRACTORS.
Left: Parsons Model 78 Trench Excavator. Right: Parsons No. 10 Backfiller Equipped with 30 Ft. Swinging Telescopic Steel Boom, Parco Traction and Automatic Scraper.

The outfit for backfilling is the same as that indicated for the other organization.

It must be understood that these organizations are set up as types of standard organization such as might be used for certain classes of work, and that various contractors interchange or rearrange the labor to suit special conditions on their work. Variations in soil character, depth of excavation, size of sewers and many other conditions will enter to change this standard organization.

Keeping Close to the Machine

It is an unwritten rule on this class of work that the laying of the sewer and the construction of manholes on the sewer should follow as closely behind the excavating machine as possible. The efficiency of this method is apparent. It is not then necessary to sheet or brace the walls of the trench as thoroughly as where other procedure is followed. The machine automatically sets the pace for the workmen to follow and this has a tendency to increase the speed of the workmen. The



VIEW OF AUSTIN TRENCHING MACHINE SUCCESSFULLY EMPLOYED ON SEWER CONSTRUCTION IN CHICAGO.

contractor is also enabled to keep his organization together and under his eye. One of the greatest economies which the contractor can accomplish is found in the utilizing of the odd laborers or spare workmen on such work. When these men are not actually performing some duty in connection with the excavation for or construction of the sewer, they can be used in backfilling over the pipe, digging out braces and sheeting and carrying them ahead, moving cement boxes, and the multitude of small duties that are found in attending such construction work.

Keeping Expensive Men Busy

The balancing of the work so that the higher priced men, such as bricklayers, machine men, etc., are not allowed to stand idle is one of the great problems of this class of work. The preparation of the excavation for the construction of manholes and catchbasins for the bricklayers and the steady repair or moving of the machine will tax the contractor's ingenuity to the utmost. Most of the work done by the contractors in Chicago, who have followed this construction for a number of years, is as carefully planned and timed as one could imagine.

Use of Steam Shovels

In regard to the larger sewers constructed in machine excavation there has been little change in the general type of machine used for this work. About 1893 a Chicago contractor conceived the idea of mounting a steam shovel on stringers across the trench and excavating for the larger sizes of sewers with this machine. This practice has been developed somewhat, and the efficiency of the organization constructing the work in this kind of excavation has been greatly improved, and, while the general arrangement is the same, the cost figures and the rate of progress show that the Chicago contractors regard it as an efficient and economical method of constructing sewers.

Manufacturers of steam shovels have constructed special booms and dipper sticks for deeper excavations and have equipped these steam shovels with larger drums and more powerful engines, showing that they have recognized this field of work.

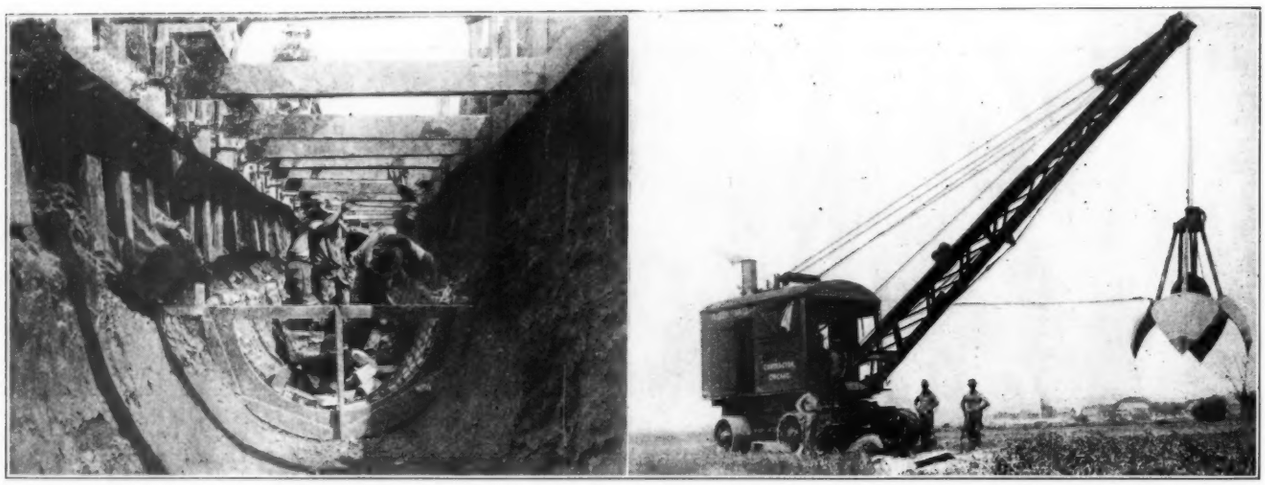
Organization for Construction of Large Sewers

The organization of the force for the construction of a large sewer varies greatly with the size of the sewer and the depth and character of the excavation. In a manner similar to that outlined in the small sewer work, this organization may be divided into three groups: the excavating, the constructing, and the backfilling organizations.

Type of Organization on Large Sewers

As a type of organization, let us take the force used to construct a 5-ft. circular brick sewer in an average cut of 15 ft. See Figure 3. The excavating force on such a job consists of the engineer, fireman and craneman on the steam shovel; one man is also engaged in carrying coal to the shovel. Working immediately around the shovel there are two men engaged in carrying planks and rollers ahead to provide the run-way for the machine. In addition, there are two men engaged in carrying up sheeting and bracing from the rear of the trench and placing it so that it may be easily reached when it is necessary to sheet a new section of the trench. Working directly below the shovel in the bottom of the cut there are four men; two of these men are usually engaged in trimming and shaping the bottom preparatory to laying the brick work, and the other two are usually engaged in running forward between each cut of the dipper and trimming the banks so that the sheeting will assume a straight line.

When the signal is given to the engineer that the excava-

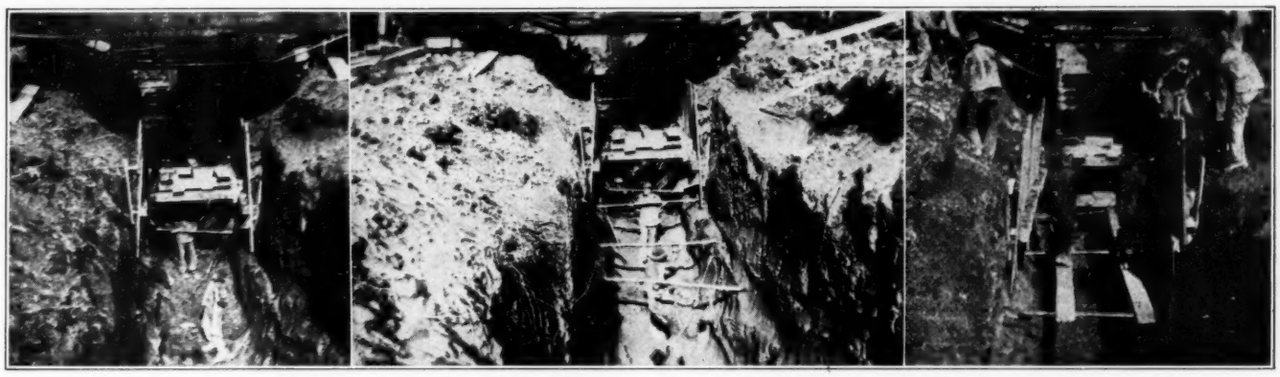


VIEWS ON CONSTRUCTION OF LARGE SEWERS IN CHICAGO.

Left: Laying the Brick Invert. Right: Clamshell Bucket Operated by Locomotive Crane; Contractors' Favorite Equipment for Backfilling Large Sewers.

tion has proceeded to a proper point the four men in the bottom carry forward a temporary scaffold and quickly place it across the trench. This usually consists of two or three pieces of 2-in. pipe cut so that they just span the width of trench. Upon these are placed 2-in. planks so that when the men stand upon these planks they can reach the level of the stringers supporting the sheeting. The four men on top then pass down the stringers and sheeting for the new section of trench to these men on the scaffold.

After the stringer has been placed and the sheeting dropped in behind, the men on the top usually cut down a little fine material so that when the brace is tightened there is a firm and even bed between the sheeting and the wall of the trench. The signal is then given for the move ahead, and the four men on the surface "stand by" to watch the rollers as the machine is pulled ahead. While this is being done the four men in the bottom are usually engaged in putting in permanent braces and stringers for the section which has just been "sheeted."



VIEWS SHOWING PROCEDURE IN SEWER EXCAVATION IN CHICAGO; STEAM SHOVEL MOUNTED ON ROLLERS OVER TRENCH.

Left: At Signal for Shovel to Stop Digging. Center: Cross Pieces in Place, Showing Method of Placing Temporary Supports for Bracers. Right: Standing Boards in Place; Lowering Stringer in Place with Temporary Brace; Sheeting Going In; Filling Behind Sheeting.

The progress of the steam shovel, aside from the ability of its operator, is almost entirely dependent upon the rapidity with which this organization carries out its work.

Rates of Progress

There have been several instances under the observation of the writer where the sheeting and bracing of a section of trench and the move ahead have been completed in from 4 to 9 minutes on the type of work indicated. The writer has also been familiar with several organizations where this same work took from 15 to 25 minutes.

In addition to the two men indicated as trimming the bottom of the trench, most contractors have found that it was to their advantage to have an additional man in the bottom setting the form for the brick work and finally shaping the trench. Nearly all contractors have found that it also pays to have a foreman whose duties are entirely concerned with the operation of this excavating crew. It is his duty to see that the steam shovel is properly lined up, that the sheeting and bracing is done properly, and that the efficiency of the whole organization is at its top notch.

Such an organization will dig from 160 to 200 ft. of trench in good clay soil in a working day of 8 hours.

If the construction organization is such as will keep pace with this organization, these rates can be maintained. Usually, however, it is found that the rates of speed on the average are not such as to justify an organization capable of constructing 200 ft. of this class of work.

The writer is familiar with a number of pieces of construction of this class, where the constructing organization was limited to 160 ft. to 180 ft. per day, and the excavating organization were allowed to go home after completing a sufficient amount of trench. These men realizing that they were working for their own personal gain, therefore developed a great efficiency and were known to go home at 2 and 3 o'clock in the afternoon after completing a sufficient amount of work for that day.

Constructing Organization on Large Sewers

The construction organization which follows behind this excavation is developed into two parts, but quite differently from the division on the small work. It is customary on this work to organize the forces into what are known as "bottom" or "invert" and "arch" crews. The "invert" gang constructs the lower half of the sewer from the flow line to the spring line. It is then necessary for the contractor to set up a temporary center for the support of the "green" brick work and the arch, and on this the "arch" gang constructs the upper half of the sewer.

Invert and Arch Gangs

The constructing organization for the "invert" of a sewer of the size indicated would consist of four bricklayers with two bricklayer tenders, two scaffold men, and two brick tossers. Carrying or wheeling brick to these tossers are two brick wheelers, and carrying cement are two cement carriers. It has been found very advantageous on this class of work to set up guard stakes and sheeting along the side of the trench against which the brick can be piled in quantity sufficient for the masonry work so that all of the brick will be within easy reach of the brick tosser and no delay result in his reaching for material. It has also been found that a long plank thrown across the trench will enable the cement carrier to hand his cement directly to the scaffold men and thereby occasion little delay in stopping the brick tossers. These cement carriers watch their opportunity and when the brick tossers and scaffold men stop for a moment, as they usually do on this work, the cement is passed down quickly to the tenders in the bottom and the tossing of brick resumed with almost no delay. It has also been found that two cement mixers are needed for this work; one mixer is usually preparing sand and cement and getting the next batch of cement ready while the other is engaged in tempering and turning over the mortar which is being used. By the time his box is empty the other is ready for use. These men are usually assisted by one laborer. As soon as the invert is completed the joints are "struck" and the organization moves ahead into the next "bottom."

Between the "bottom" gang and the "arch" comes the "center setter." It is his duty to "strike" or take down the centers after the work is set, carry them forward and set them up ready for the new work. This work usually requires a major portion of his time, but when a man becomes skilled at

the work he has considerable time during which he is usually engaged in "cleaning down" the arch or wheeling ahead the surplus cement from the completed work. On these forms the "arch" gang constructs the brick work in two sections. Usually there are four bricklayers in such a crew working in pairs. The two leading bricklayers construct the wall from the spring line up, turning the so-called "quarter," while the two followers close or "key up" the arch.

Maintaining Progress Balance Between Invert and Arch Gangs

The organization for cement and brick is practically identical with that of the "bottom" crew. When it is necessary to construct a manhole on the sewer, one bricklayer is usually detailed for this work. This necessitates a slight rearrangement of the gang and usually slows up the arching process, and it frequently becomes necessary to bring back the bricklayers from the bottom and turn a sufficient amount of arch so that it may be kept fairly close behind the invert construction. Any such rearrangement of crew results in confusion, and the contractors are more apt to put on extra bricklayers in either "bottom" or "arch" gang so that proper balance may be maintained. The difficulty in employing an extra bricklayer comes from the fact that it usually necessitates the employment of an extra tender. These tenders are capable of handling material for two bricklayers, and the contractors are more apt to employ two bricklayers at a time and endeavor to balance the rate of construction by sending them from the bottom back to the arch and vice versa. Such an extra crew understands its duties and performs them with less confusion than that occasioned by the transfer of the whole "bottom" or "arch" gang.

TWO METHODS OF PULLING SHEETING ON CHICAGO SEWER CONSTRUCTION.

Upper: Lever Method; Five Men Required. Lower: By Two-Speed Builders' Hoist; 3 Men Required.

In charge of this constructing organization there is usually a foreman whose sole duty is to see that the materials are kept moving properly and regularly to the workmen, and that the proper balance in rates of construction is maintained between the arch and the invert. Following this constructing crew there are usually three or four men taking out braces and removing sheeting from the trench. Supplementing this work there are two men engaged in carrying this material ahead to the new excavation. Where the shovel is maintaining a fair rate of excavation, the travel of these men from the rear to the shovel may be as much as 200 or 300 ft. As the sheeting and braces are easily taken out, the men engaged in their removal usually have sufficient time to cut down the sides of the bank and backfill around the sides or quarters of the sewer before the centers are struck.

Backfilling With Orange Peel Bucket and Locomotive Crane

Following this organization comes the backfilling. On the class of work indicated several types of backfillers have been developed. The range of experiments for this purpose seem to have covered the whole field. Almost every imaginable type of machine has been tried out—drag line buckets, orange peel buckets, clam shell buckets and many special types of buckets have been tried. In general, the Chicago contractors have conceded that the best type of machine for this class of work is the orange peel bucket carried by a locomotive crane. This machine is self-propelling, has a wide range of operation, and is capable of cleaning up the work in very good shape, and is usually operated by one man. It has been found that two laborers accompanying such a machine are usually sufficient. These men adjust the track or run-way for the machine and maintain the water connections. Such an organization as that indicated is ample for maintaining the rate of speed indicated under the excavating.

Value of Skilled Labor

It must be borne in mind that this organization as outlined is typical for one condition only, and is simply a standard which has been established by practice among the Chicago contractors, and is based upon the rates of pay and efficiency of the Chicago workmen. These men are peculiarly skilled in their work and are familiar with local conditions so that the efficiency maintained is uniform and can be duplicated in any one of several organizations.

The employment of unskilled labor in this class of work has usually been disastrous, and the time and labor spent in training them is usually far more costly than the higher wage paid to the skilled workmen.

Sources of Delay

As in the case of the smaller sewers, the opportunities for economy are many. Delays in machine excavation due to breakdown of machinery or bad or caving ground under the shovel often require the contractor to readjust his organization entirely, and even under the best conditions the contractor must be constantly on the alert. One of the frequent sources of delay is lack of sheeting. If the ground becomes very good the contractor is tempted to speed up the excavating, and soon finds himself with all his sheeting in place and nothing left for the new excavation. Oftentimes the excavated trench will cave under the sheeting and require excavation by hand on scaffold. This introduces great delay.

The Chicago contractors believe that they have developed their constructing and other organizations to a point far ahead of that found in any other similar work. The writer believes that this opinion is largely justified, but believes that it comes about more largely through the attention given to the individual workmen and the training and skill which have been imparted him. The peculiar labor conditions obtaining in Chicago have restricted this field in certain ways, so that the class of men employed has been fairly constant and their skill has increased accordingly. The rates of pay are exceedingly high when compared with common labor, but it is the opinion of the writer that the workmen are more than common laborers and that the results attained by them for their contractors have more than justified the high rates of pay. This is true on both classes of sewers, both small and large.

Facilitating the Construction of Water and Sewerage Works by Means of the Cement-Gun

In recent years, the Cement-Gun has established itself as one of the dependable working tools of the engineering and contracting professions. We present herewith several specific examples of the successful application of the Cement-Gun process in the construction of water and sewerage works in various American cities:

Columbus, Ohio

One of the views shown herewith illustrates the use of a Cement-Gun on the reconstruction of the well known sewage disposal works at Columbus, Ohio. This work was let with the specifications calling for 3 in. walls on the sides of the slope chambers. An unsuccessful attempt was made to pour concrete walls of this thickness. The resulting concrete was of such poor quality that it quickly disintegrated. A Cement-Gun was then brought on the job to correct this difficulty, and the trial was so successful that the practice of pouring thin walls was abandoned and the remaining walls were built up by the gun, as shown in the photograph, the gunite being shot against the reinforcing metal. The result was quite satisfactory.

Albany, New York

At Albany, N. Y., the Cement-Gun was used to cover concrete tanks with a coating of mortar. The operation of the gun at Albany was so rapid as at times to require the employment of 10 to 12 masons to trowel the applied surface.

USING THE CEMENT GUN PROCESS TO CONSTRUCT 3-INCH WALLS IN COLUMBUS, OHIO, SEWAGE SETTLING TANKS.

Views are shown herewith of the sewage disposal plant at Albany, on which this work was done. One of the views shows a general view of the plant under construction, and the other view shows concrete being covered with cement-gun mortar. Note the fact that in this illustration, one cement-gun is keeping five masons busy troweling the surface.

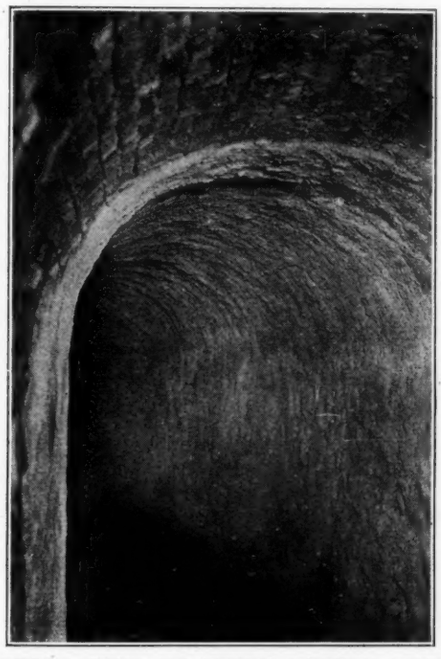
In a letter to the editor, relative to this work, Mr. Stephen B. Vernon, engineer of Intercepting Sewer Design and Construction, of Albany, advised that the inner slope walls of the Imhoff tanks in the Albany sewage treatment plant, were coated with about ¼ in. thickness of the gunite, and this was troweled smooth. This was not done for water proofing purposes, but rather to get an absolutely smooth surface, down which the sludge would easily flow to the sludge chambers. Mr. Vernon states that in the application of the gunite, they seem to have secured good results. As to the choice of methods for doing this kind of work, there is the use of the gun and troweling by hand, and the former was chosen because the cheaper. Undoubtedly the best results could have been obtained by troweling the original concrete soon after its initial set. This was impossible of accomplishment, since the work would have suffered during the after-construction and the smooth surfaces would have required a large amount of repair.

In troweling gunite, masons should be cautioned not to make too free use of their floats and trowels, because of the danger of injuring the permanency of the plastered coat.

St. Louis, Mo.

Some very interesting work has been done by the City of St. Louis, using the cement-gun in making repairs on old sewers. The engineers of the City of St. Louis conducted experiments to determine the availability of the cement-gun for relining old sewers of large diameter. Theoretical considerations indicated that the capacity of rough brick and ashlar sewers could be increased sufficiently by the addition of a smooth mortar lining to make possible a large saving in cost of proposed relief sewers. In addition to the increased carrying capacity of sewers so lined, the sewer structure is obviously made stronger by filling in the joints of the old masonry in this manner.

A length of sewer was selected for the demonstration, in



INTERIOR VIEW OF FERRY STREET SEWER, ST. LOUIS, SHOWING OLD SURFACE BEFORE AND AFTER LINING WITH CEMENT GUN MORTAR.

which were combined both ashlar and brick masonry, and which was of small enough diameter so that all parts could be reached without the use of scaffolding. Wire brushes were first tried for preparing the sewer walls for the mortar coat, but were not found satisfactory. The sand blast was also tried, but failed because of insufficient compressed air. The method finally successfully adopted was to pick and scrape the mortar out of the wall with a tuck-pointer's tool. It should be noted, however, that many old sewers are so thickly covered with foreign growths as to be unsusceptible to any scarifying method other than the sand blast, and sufficient air compressor capacity should be provided to convert the gun into a sand blower where necessary.

The St. Louis work was begun in the year 1915 and has been uniformly satisfactory. Many of the old brick sewers in that city were built with natural cement joints before the use of Portland cement became common. In many of these sewers the brick joints have been eroded to depths varying from several inches on the sewer invert to almost nothing around the sewer crown.

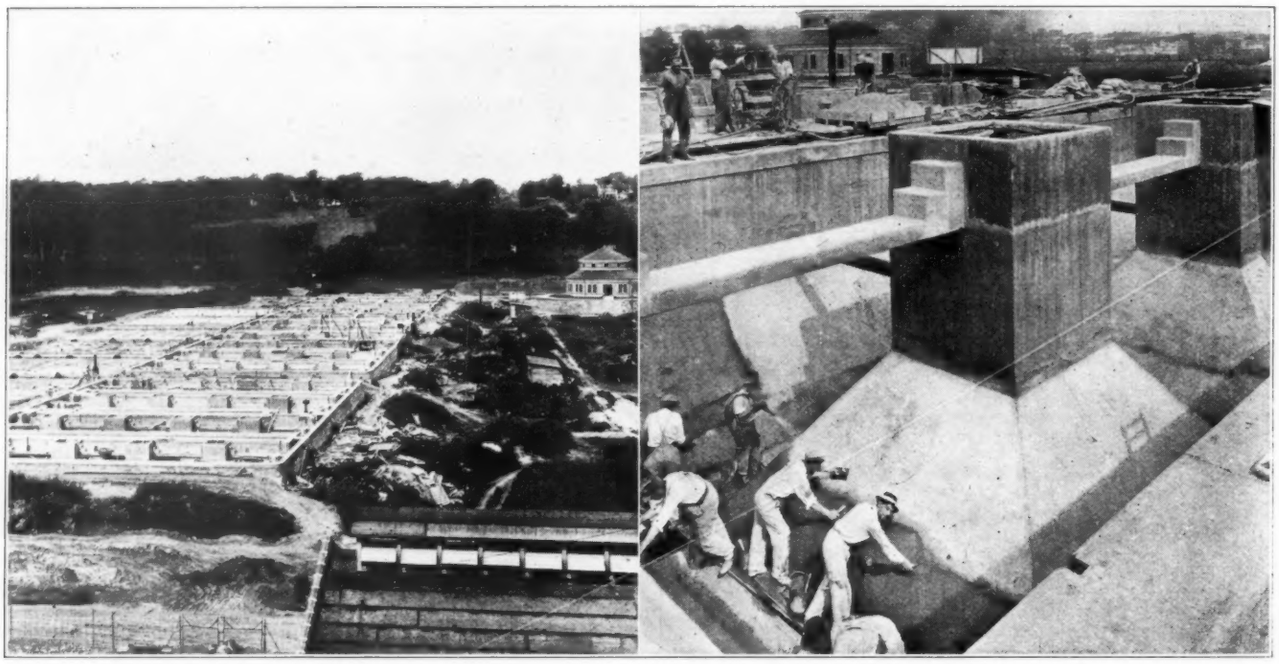
The sewers were treated with a mortar coating of the minimum thickness and were troweled where this was justifiable. Where the invert had disintegrated to a dangerous extent, the flow of the sewer was by-passed and the invert was reconstructed with vitrified brick up to the point reached by the gunite. On this work, both the gun and the compressor were operated on the street surface, while only the nozzleman, one signalman and the surfacers worked inside the sewer. Early in March of this year, Mr. L. Chivvis, Principal Assistant Engineer of Sewer Design, at the request of the editor, made another inspection of the work done by the cement-gun on the Ferry Street sewer in St. Louis, in 1915. This lining, he reports, most of which was put on without previously roughening the walls with a sand blast, is today in perfect condition. He advises that the present views of the St. Louis engineers on the utility of the process are very favorable, and they would probably be using it exclusively but for the present high cost of material and labor. A view is shown herewith of the lining placed in the St. Louis sewer by means of the cement-gun.

San Francisco, California

One of the first applications of the cement-gun in water works construction was the case of the water-proofing of the division walls in the Twin Peaks Reservoir in San Francisco. Mr. M. M. O'Shaughnessy, City Engineer, states that early in the year 1912, it was decided to attempt to make a concrete wall dividing two halves of the reservoir water-tight by means of cement plaster applied with a cement-gun. This wall was of reinforced concrete 280 ft. long on top, 16 ins. thick at the bottom, 10 ins. thick at the top and 27 ft. high.

When one-half of the reservoir was filled with water, to a depth of 8 ft., the water seeped through the wall and ran down into the other half of the reservoir. The reservoir was emptied and both sides of the wall plastered with cement plaster about ¼ in. thick, applied by means of a cement-gun. After standing for about five days, the west half of the reservoir was then filled to a depth of 26½ ft. and kept filled for five days. During all of this time, the surface of the wall on the unfilled half of the reservoir showed no signs of dampness, indicating that the cement plaster was absolutely water tight. Mr. O'Shaunghnessy states further that the bond between the cement plaster and the concrete wall was found to be perfect. Even when a hole was chipped through the plaster into the wall, it was difficult to find the joint between the plaster and the concrete, and upon attempting to chip the plaster off from the wall with a cold chisel and hammer, the plaster was found to be thoroughly bonded to the concrete.

Following the successful application of this process on the Twin Peaks Reservoir division wall, the engineering department of the City of San Francisco has used the cement-gun for plastering in both the inside and the outside walls of a car barn for the Municipal Railway and for a reinforced concrete building constructed for housing a garbage incinerator. Mr. O'Shaunghnessy states that in all these cases he found the adhesion between the plaster and the cement to be perfect, and he considers the work far superior to any hand plastering which has come under his observation.



CONSTRUCTION VIEWS OF SEWAGE TREATMENT WORKS AT ALBANY, N. Y.

Left: General View of Plant. Right: Plastering Concrete Surfaces in Settling Tank with Cement Gun Mortar; One Gun Keeping Five Masons Busy Troweling the Surface.

Miscellaneous Examples

A reservoir at Muscatine, Ia., was built several years ago, partly on a fresh fill. This fill settled and the reservoir wall broke down to such an extent that the reservoir could not be used. The concrete lining was badly damaged. Repairs were made with the cement-gun, which proved to be highly successful.

The wash water tower at the Torresdale Water Filtration Plant in the city of Philadelphia, was becoming dangerous due to the leakage of water along the lines of separation between successive days work in the original concreting operations. This seepage water froze and caused the spalling off and disintegration of the concrete. In 1916, a contract was let for the repair of this tower, it being specified that the inner walls should be dried, cleaned and coated with a 5-ply membrane water-proofing, over which 2 ins. of reinforced cement-gun mortar should be shot on. On attempting to place the water-proofing membrane, it was found that no adhesion could be obtained on account of the damp walls. The membrane was then painted and the walls were lined with 1 in. of gunite, and reports indicate that all leaks from the tower are permanently stopped.

The city of Elmira, N. Y., built a large reservoir in 1911.

In 1916, the concrete walls had disintegrated to such an extent that in places pits were found from 3 to 4 ins. deep behind the reinforcing rods. A contract was let in 1916 for repairing this structure with the cement-gun and this proved quite successful.

An interesting application of the cement-gun process was made in the construction of the new reservoir of the Anaconda Copper Company at Great Falls, Montana. Instead of following the usual practice of lining a concrete reservoir with 1 to 2 ins. of reinforced gunite, the engineers of this company, Messrs. W. C. Tanner, Chief Engineer, and W. G. Capron, Asst. Chief Engineer, decided to line the basin entirely with gunite, with two layers of reinforcement. Reports of this work indicate great success in procuring an absolutely water-tight reservoir and also in getting this result at a very low cost, as the use of all transporting and other heavy machinery, as well as forms, was eliminated.

WATER WORKS DESIGN AND CONSTRUCTION

The New Mayfair Pumping Station of the Chicago Water Works

The Mayfair Pumping Station of the Chicago water works, is located at Wilson Avenue and North Lamon Avenue. It will supply water to the extreme northwest part of the city and will also maintain a high pressure system for high level territory. Work on this station was commenced in September, 1915, and, at the time of writing (May 15), it is expected that the station will be placed in operation on June 1, 1918.

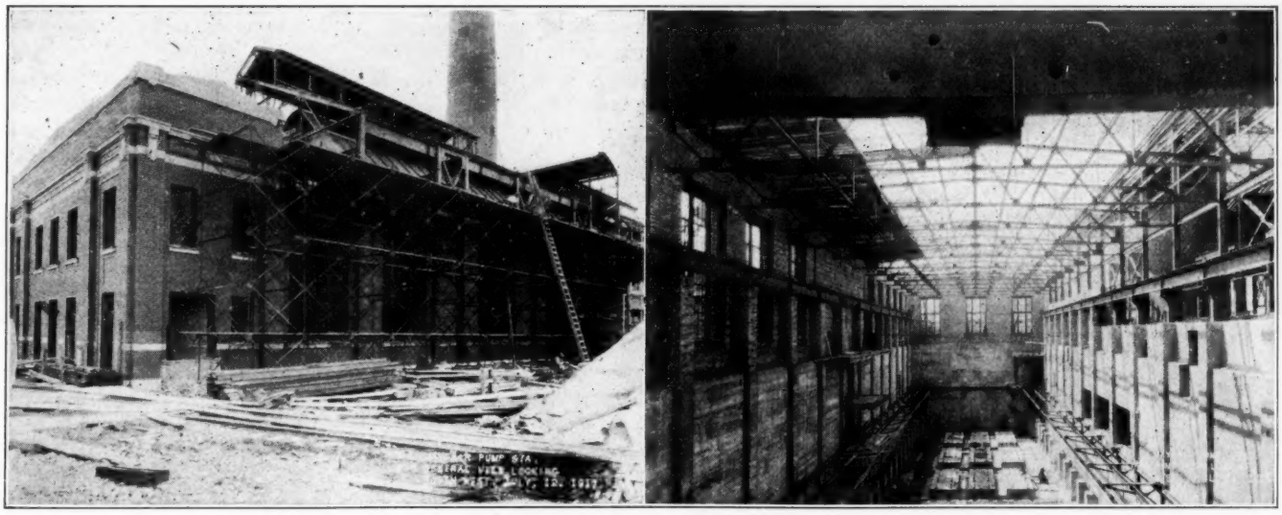
The building fronts south on Wilson Avenue, with a pump room 236x60 ft., the floor being at elevation 7.15, or 38.65 ft. below street grade. There is an office section one story high, 50x31 ft., in the center of the south front. The boiler room, 204 ft. by 54 ft. 9 ins., lies north of the pump room. The basement level at elevation +13.92 is 17.58 ft. below street grade and the main floor, at elevation +28.84, is 2.66 ft. below street grade. A coal receiving room, 72 ft. 9 ins. by 70 ft. 9 ins., is located north of the boiler room, leaving an 18-ft. driveway between the two.

A sidetrack turning south from the C., M. & St. P. Ry. will carry coal cars into the receiving room over three receiving hoppers. The coal can be unloaded directly into the hoppers through bottom dump cars or by means of a grab bucket from an overhead traveling crane, or the coal can be stored in bins on both sides of the track hoppers.

The coal, after passing through a crusher under the hoppers, is carried south on an apron conveyor to the main bucket conveyor running east and west in the boiler room 4 ft. north of the boiler fronts. This conveyor supplies a set of enclosed bunkers 17 ft. 6 ins. long, which have a capacity of 1,000 tons. Spouts feed the coal from the bottom of the bunker 22 ft. above the boiler room floor to each stoker.

The boilers, which front north, supply steam at 175 lbs. pressure through a double header system to the seven pumping engines. The steam for the pumping engines is supplied by a battery of six four-pass Edge Moor water tube boilers equipped with Taylor stokers.

The smoke breeching is suspended from the main floor and enters the central stack from the east and west. The stack is 184 ft. 2 ins. high above the boiler room floor, inside diameter 8 ft. at top and 14 ft. 5 ins. at base and is supported by four 5-ft. caissons extending to solid rock at elevation —50.0.



CONSTRUCTION VIEWS OF MAYFAIR PUMPING STATION, CHICAGO WATER WORKS.
Left: General View of Station Looking Southwest; Photographed July 12, 1917. Right: Interior View of Pump Room Looking West, as Photographed April 24, 1917.

The water is pumped by seven pumping engines of a total capacity of 152.5 million gallons per 24 hours. The pumps are triple expansion crank and flywheel type, with mechanically operated suction and discharge valves of Riedler design. Water is to be conveyed to the station from Lake Michigan through the new Wilson Avenue Tunnel.

The steam ends of both high and low pressure pumps are alike, but the water ends of the three west pumps are smaller. The three west pumps will each deliver 17.5 million gallons per day against a 200-ft. head, and the four east pumps will each deliver 25 million gallons per day against a 140-ft. head.

Each pump has two suction nozzles extending south and

then down into a common suction tunnel, whose flowline is 20 ft. 10 ins. beneath the pump room floor. All the water entering the pumps passes around the tubes of a surface condenser and is discharged through four pipes from each pump into the two station mains.

There are two discharge mains for the 140-ft. head, one north and one south of the pumps at elevation -4.0, extending the full length of the station, leaving at the west. They are supported by a series of piers adjacent to the north and south walls. The two high pressure lines start at about the center of the building and are supported by saddles on the other pipe and also leave at the west.

Immediately west of the station are two pipe vaults, in which the pipes rise to street grade and change direction to conform with the general layout of the street pipe system.

Contracts

The J. U. Boland Construction Co. was given the contract for the chimney on the alternate design of a concrete bore, veneered inside and outside with brick, at a total cost of $10,480. The City built the four chimney caissons and slab. The circular base from the slab at elevation +9.00 to elevation +33.84, which was part of the chimney contract, was also built by city day labor under force account work for the contractor.

The Lakeside Bridge & Steel Co. was given the contract for all the structural steel. The pumping engine contract was executed by the Allis-Chalmers Manufacturing Co. of Milwaukee.

Personnel

The engineering work at this pumping station during its construction, was in local charge of F. Carl Martini, Assistant Engineer. Henry W. Clausen is Engineer of Water Works Construction. John Ericson is City Engineer.

Present High Prices on Water Works Materials Will Continue After the War

By Robert E. McDonnell, of Burns & McDonnell, Consulting Engineers, Interstate Bldg., Kansas City, Mo.

After-the-war prices of water works materials have greatly concerned superintendents of both municipally and privately owned water plants; but, now that the war is in its fourth year with no end in sight, the public is gradually adjusting itself and becoming reconciled to war prices. The water works officials who have withheld improvements and postponed purchases now find themselves in a sorry plight by facing a prospect of still higher prices after the war. Had the war been of short duration things would have been different. The war has already lasted long enough to establish new economic conditions that will not be changed soon when the war is over, said Mr. McDonnell, in addressing the Southwestern Water Works Association.

Labor Question

The price and availability of labor, both skilled and unskilled, is one of the chief determining factors of prices. Mechanics and skilled workers in pump factories, valve and hydrant factories, meter factories and pipe foundries are now receiving about twice to three times their former wages, and the laborers having once accustomed themselves to short hours and high wages, new habits of living are formed. Imagine in your own case what you would do if after enjoying for several years $200 per month, you were required to readjust your affairs to a salary of $150 per month. You probably would not accept it, but engage in something else of a similar nature. Labor of unskilled kind would not be content with reductions, and the labor that has gone to war, will, upon coming back, be of an entirely different character from what it was when it left the water trenches for the fighting trenches. A few years fighting for his country, seeing new lands, new cities and mingling with intense activity will completely transform the man to one of higher ideals and aspirations. He will no longer be content with the menial tasks. He will learn that he is capable of doing bigger things. The contractor, the farmer, the foundryman and the manufacturer who are looking for their labor back again after the war will look in vain, for their mental, moral and physical changes will be so great that the men who return will have other things in view.

Labor cannot help being the scarcest commodity in America for at least several years after the war. Previous wars, although trifles compared to this war, were examples of producing a scarcity in labor for years following their close.

Post-War Foreign Attractions for Americans

A wonderful equalizing effect will also result. The restoration of ruined cities in Europe will attract American engineers, contractors and material dealers. We are now, as a result of our new knowledge of the world, bidding on foreign work with the same keenness as if the job were in an adjoining city. The immense merchant marine now used for war purposes will, after the war, convey labor and materials readily to every part of the world. France, South Africa or Egypt will then be almost as accessible as remote parts of America.

American Water Works Materials Much Wanted Abroad

Foreign countries will not have the barriers that formerly existed. Our machinery, pumps, pipe, meters, filters and supplies of every description have since the war started been tried out abroad and are so well liked that American factories are now busily engaged in shipping water works supplies to China, South Africa, Palestine and all South American Republics; in fact, all over the world. Our mechanical filter plants have so pleased the South American countries that they will not be satisfied with any other. One of our own assistant engineers now in Uruguay supervising the installation of a water works, lighting and sewerage system writes that the Uruguain officials are so well pleased that American engineers, contractors and materials will have the preference. These markets opened up since the war are not going to close after the war.

A demand has been created that will continue, and *demand* is one-half the cause of price making. If the labor to produce the supply is going to be scarce we then have a scarcity of supply and an increase in demand—two functions that tend to maintain high prices.

The Unwise Waiting Policy

Many cities have waited and continued to wait, expecting lower prices. Cities requiring water purification plants have continued to use polluted supplies, thereby endangering the health of their citizens, all because of a mistaken idea that prices would be lower right after the war. Fire protection equipment both in pumps, larger mains and fire apparatus, has been postponed awaiting lower prices after the war, until now we have inadequate fire protection in many cities. This condition, already alarming, is made doubly dangerous by the frequency of incendiary fires throughout the country. The holding off of these improvements until after the war would increase the normal demand to the point of producing an increase in prices following the war. Cast iron pipe, the largest item of cost in water works construction, is held down in price now only by the governmental control of the pig iron price, and with foundaries already petitioning the government to permit an increase one can readily see that with the governmental control removed the price would immediately go upward. The same is true of the copper market control. The demand for copper was never greater than at present in the history of the world and when the government regulation of the price is removed copper will immediately go upward to meet the demand.

Waiting Cities Will be Disappointed

Cities, therefore, holding back lighting improvements or electrifying their pumping plants in anticipation of lower

prices, are going to meet with disappointment. The war demand for water works materials has been no greater than similar demands for all classes of commodities. The use of American materials in the war has served to demonstrate their adaptability which in itself will create new markets. One of the remarkable achievements of the war accomplished through American water works materials, was the capture of Palestine from the Turks. The capture of Palestine in the past was attempted many times in the last 1400 years, and the British attributed the failures to the lack of water supply. With the use of American made pipe, pumps, valves and equipment, a 10-in. pipe line was laid 150 miles across the desert, supplying drinking water for the troops, camels and munition trains. The pipe was carried in by camels and water was made available for use as the pipe laying progressed.

Prices After Other Wars

Facts taken from history give excellent precedents as to what we may expect in the future prices. In the period covered by the French Revolution, America was also engaged in war with England, so that at that period practically the whole civilized world was at war. While business was small then, yet prices went through the same performance they are repeating today. Prices after the war rose and remained at the maximum during the war for a period of about five years after the close of the war. In 1864 the increase was about 50 per cent. above the normal of 1851. The decrease toward normal was only about 20 per cent., covering several years with a sharp increase again at the Franco-Prussian War in 1871, and the prices did not return to normal until 1880, ten years after the close of the Franco-Prussian War.

View of New York Board of Water Supply

Prices in time will undoubtedly seek their normal level, but cities, like individuals, need water for their growth. Can we afford to stunt the growth of a community by waiting for lower prices? This question has been carefully studied by those most competent to pass opinion. Recently a report was made by the New York Board of Water Supply to the Mayor of New York, which states "That there are no convincing evidences that labor and materials will be less expensive now or for several years to come," and further makes the suggestion that "many well informed persons are of the opinion that the tendency will be higher and still higher prices for water works commodities." The report closes with the recommendation that the city's interests will be best served by the continuous and speedy prosecution of the water works improvements to their final completion.

Water is fundamental to the growth and prosperity of every community. An abundant supply of good pure water is a city's most valuable asset. Its industries cannot be secured or maintained if the water supply is inadequate.

The Capital Issues Committee of the War Finance Corporation in giving approval to water works bonds has gone on record as to water supplies and their improvement, as being an essential improvement, and all worthy projects are meeting prompt approval.

The essential feature in the whole problem to consider is the responsibility of the water works profession toward the health of the community. Nothing has such a great bearing upon the health of the community, as the quality of the water. Can the water boards, mayors, superintendents and engineers afford to defer improvements when that postponment may mean an epidemic of typhoid or other water borne disease? The loss of lives cannot be justified by a saving in dollars.

Some Design Features of the Waban Hill Covered Reservoir of the Newton, Mass., Water Works

By Edwin H. Rogers, City Engineer, Newton, Mass.

The extension of the covered water works reservoir on the summit of Waban Hill, in the city of Newton, Mass., as designed by and constructed under the supervision of the city engineer's department, was completed on November 30, 1917, except for the installation of certain gates and piping within the gate chamber.

The reservoir, as now extended and completed, comprises four rectangular sections, with a circular chamber at the center, in which are installed a steel distributing tank and pipes from the force main to the different sections and the overflow pipes and drains for emptying the different sections.

The Four Sections of the Reservoir

Section 1 is the southeasterly section and was built in 1890; section 2 is the southwesterly section and was built in 1901; sections 3 and 4 are the northwesterly and northeasterly sections, respectively, and were built in 1916 and 1917.

The types of construction of sections 1 and 2 are nearly the same, whereas the design adopted for sections 3 and 4 is radically different from the older type. Sections 1 and 2 are built with rubble masonry gravity walls extending 3 ft. below the floor of the reservoir, the roof of these sections being supported by brick columns on rubble masonry foundations below the floor. The roof of section 1 is brick cylindrical arches, supported by other arches at right angles springing from column to column, and the roof of section 2 is of reinforced concrete flat slab construction, supported by longitudinal steel I-beams spanning the distance between the columns and walls. All of the sections have the roof covered with loam.

Design of New Sections

Sections 3 and 4 are built of concrete throughout, the walls being 2 ft. to 2½ ft. thick at the top and 4 ft. thick at the bottom, and the walls as well as the columns are constructed of it and rest directly on the floor, which is a concrete slab 12 in. thick under the walls and a short distance inside, and 8 in. thick under the rest of the structure. The walls are reinforced so as to act as a beam to resist the earth pressure of the embankments, and the floor under the walls is reinforced at the corners. The floor under the columns is reinforced by a grillage of steel rods, thus distributing the load on the columns in such a manner as not to exceed a suitable pressure per square foot on the supporting soil. The floor was further reinforced by 6x6-in. galvanized Clinton wire cloth lapped at all joints, to distribute temperature stresses occasioned during construction. The floor is level, at grade 305.27, Boston City Base.

The roof is of groined arch construction without reinforcement, the intrados being semi-elliptic with a rise of 3 ft., the extrados being parabolic with a drop of 9 in. over the columns, the thickness of the arch at the crown being 6 in.

The columns are without reinforcement except for dowels at their bases connecting them to the floor and pintles at their tops running into the haunches of the arches.

The walls were reinforced longitudinally sufficiently to prevent cracking between the expansion joints, which were inserted at intervals of from 30 to 35 ft. These expansion joints are provided with a folded sheet lead dam to prevent leakage and a sheet steel dam is provided between walls and the floor for the same purpose.

Cast iron ventilators with openings consisting of narrow slits are provided in the roof, and one cast iron manhole in each section provides access for inspection and cleaning.

The 24-in. cast iron inlet pipes enter the sections at the flow line, continue of cast iron on a slant to the floor, and are extended along the floor of vitrified pipe construction imbedded solidly in a concrete base. The flow line is at grade 320.27.

The sections are covered with filling and loam 18 in. in thickness over the crowns of the arches, and embankments on a 2 to 1 slope are built adjoining the outside walls and covered with 12 in. of loam. The excavation for the site of these sections was done largely with a steam shovel and horse-

drawn dump carts, the material excavated from the site providing the greater portion of the filling and loam required.

Construction Plant Employed

The construction plant consisted of a wooden tower over 100 ft. in height, erected on the northerly side of the sections No. 3 and 4, opposite the retaining wall between them, with the concrete mixer at its base, and bins for the storage of the sand and stone on the northerly side of section 3, whence the aggregate was conveyed to the mixer by an industrial railway operated by a cable from a stationary engine which furnished the power for the mixer and the elevator in the tower. Chutes from the tower in several sections were provided of lengths sufficient to reach to any part of the work and were used for placing most of the floor and walls. These chutes were difficult of operation unless a large percentage of water was used in the concrete, and so their use was abandoned for the placing of the columns and roof work, in which a dryer mixture of concrete was advisable than used in the floor and walls.

The concrete for the columns and roof was dumped from the tower directly into steel concrete barrows or buggies and pushed by the workmen where required.

Wooden forms were used for the walls, steel forms for the columns and the capitals of the columns part way up the arches, and wooden forms for the balance of the groined arches, the latter forms being supported by wooden posts from the floor.

Crushed stone was used for the coarse aggregate in the concrete and the sand and cement were frequently tested and found to meet the specifications in each instance.

The floor was finished by the use of a roller made of a 3-in. pipe, a method which has since been adopted in many instances for the finishing of concrete roads. The walls and columns were washed with grout after the forms were removed.

The capacity of the sections of the reservoir with the water at the full depth of 15 ft., are approximately as follows:

Section 1, 2,300,000 gals.; section 2, 2,200,000 gals.; section 3, 3,000,000 gals.; section 4, 2,900,000 gals.

Cost

The work of relocating the water mains in the vicinity of the reservoir, the furnishing of the iron castings for ventilators and manholes, the furnishing and installation of the piping and other incidental work, was done directly by the water department forces at a cost of $5,252.92; the cement gun work was done by John O. Ballentine, of Peabody, Mass., at $700; the balance of the work, which included all excavation and grading, concrete construction, furnishing of reinforcing bars, form work, and all work incidental thereto, was executed by the Old Colony Construction Company, 6 Beacon street, Boston, at a contract price of $59,699.40. The contract of the latter company was dated June 8, 1916, and was prosecuted to successful completion in the face of rising prices of labor and material, and at what was obviously a substantial loss to the contractor.

Methods Employed in Reconstructing Fort Madison, Ia., Water Works Plant on Exact Site of Old Plant Without Interrupting Operation

The water works plant of the Fort Madison, Iowa, water works system was recently completely reconstructed on the exact site of the old plant without any interruption to the water supply whatever.

During this reconstruction process, every bit of the material and equipment in the old plant was replaced with new material and equipment. Naturally this was a piece of engineering work calling for unusual preliminary planning and study and also for a careful handling of the construction materials and methods.

While it is not an unusual thing to replace an old steel bridge with a new one without interfering with the traffic, it must be remembered that in bridge work a short interval at least is had between the successive passage of the trains or vehicles using the bridge, but in supplying water to a city of 15,000 people, with continuous water service, there can be no interruption to the supply, even for a minute without jeopardizing property and public health as well.

It is a fact that cities oftentimes contemplate the reconstruction of an old water plant, but hesitate to undertake this work because of the fear of interrupting the service, realizing that such interruption will result in criticism of the officials in charge.

At Fort Madison, however, criticism had reached an advanced stage because of the quality of the water supply and the inadequacy of the fire pressure, so the city officials decided to rebuild the water plant to secure a better quality of water and better fire service.

As the city was unable to issue bonds to defray the cost of building a municipal plant, 25 of the leading citizens organized the Citizens Corporation, which was granted a franchise, immediately took hold of the old property, and began the reconstruction of the water works plant at an expenditure of about $300,000.

The old plant had not operated at a profit, so the new corporation was very desirous of making such changes in the plant, and in introducing such economies in operation, as would make the new venture a profitable one from a business standpoint.

The consulting engineers, Messrs. Burns & McDonnell of Kansas City, Mo., in preparing the plans and specifications for the requisite machinery and equipment for the pumping plant, power plant and filtration system, also kept in mind the unprofitable results of operation of the old plant, and made every effort to provide equipment that would give the best of service at a minimum operating cost.

It is obvious that the building of a new water plant on a new site with a new source of supply is quite simple in comparison with such a reconstruction project as that undertaken at Fort Madison. At this city the old station, like many old water plants, contained obsolete pumping machinery and a power plant that was wasteful of fuel. There was no check on wasteage of water, and due also to frequent changes in management, very uneconomical operating conditions existed.

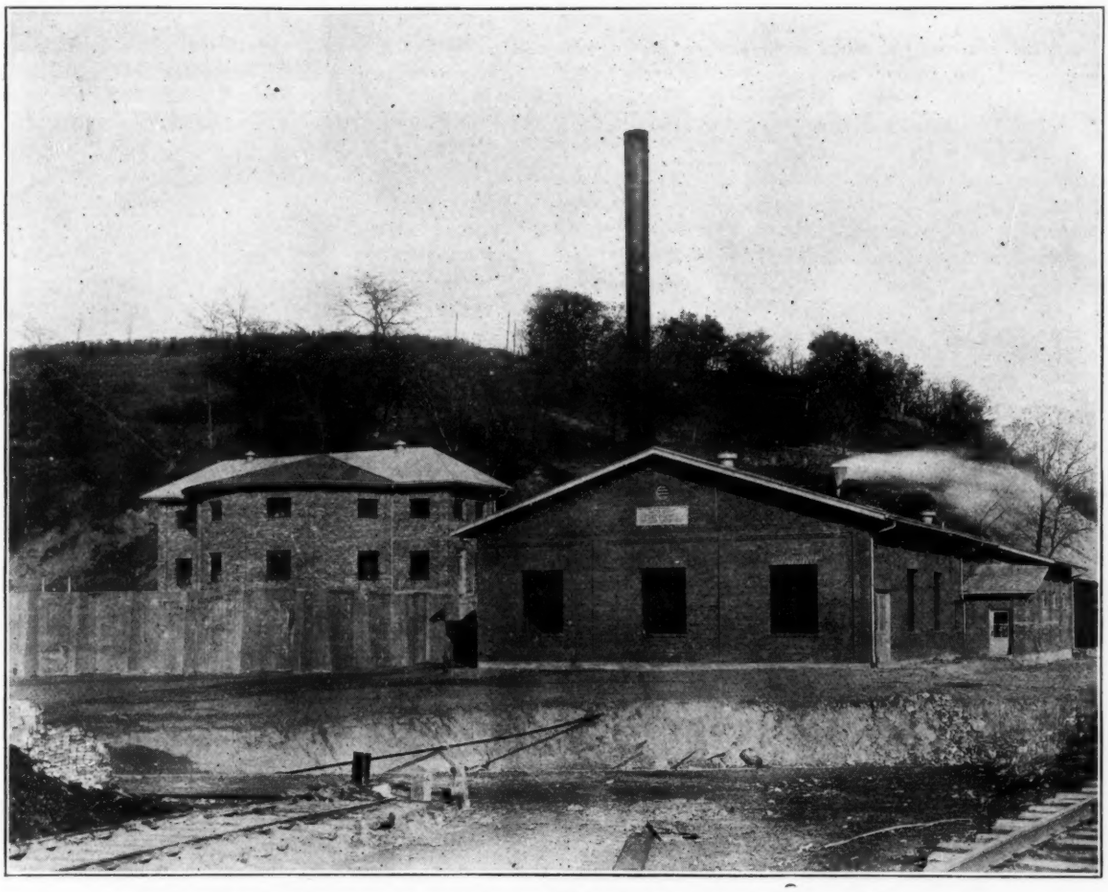
The old station contained two high service pumps, but only one was in operating condition. The old brick station building was torn down from around the old pumps and boilers, and the equipment was covered with canvas, and excavation for the new structure was started. Practically the entire work of reconstruction was carried on during severe winter weather. In making the excavation for the new structure, it was found necessary to take up the old discharge lines from the pumping plant and to replace them with temporary connections.

The first work undertaken and completed was the construction of a 1,000,000-gal. reinforced concrete storage reservoir to provide some storage of water in case of interruption in pumping. One old boiler was disconnected and discarded; foundations were built and the new boiler was then erected and put in operation. Then the second old boiler was removed and foundations were built for the second new boiler, which was then connected and enclosed in a new steel casing.

A temporary smoke stack, made of old corrugated iron culvert pipe, was erected and supported above the boiler by structural steel frame taken from the old building. This temporary stack was also supported by guy wires placed so as not to interfere with the later work of placing the roof trusses and other building operations. A complete new stack was erected, and as soon as the new boilers were placed the new breeching was put in place and connected to the new stack.

While these changes were being made, the building was being constructed, and firemen, engineers, and other operatives were protected by canvas covers stretched over frame work above the boilers and pumps and, despite the severe winter weather, this work was carried on without interruption.

In the pump room a new concrete foundation was erected, and the new pump installed. New steam connections were at once made and the old pump was dynamited. This old pump had seen about 32 years of service and had twice been welded together to keep it in operation, so it was not considered of sufficient value to save. Fortunately, the new pump had all of its connections completed and was ready to be placed in service when the old pump broke down completely. Steam was then turned into the new pump immediately after the collapse of the old pump, and continuous service was maintained, with scarcely an interruption except for a few minutes for making adjustments to the new pump.



VIEW OF RECONSTRUCTED WATER WORKS PLANT AT FORT MADISON, IOWA.
Pumping Station and Coal Storage on Right. Settling Basin, Filter House and Head House on Left.

The new high service pump is of the Corliss Fly-Wheel type, and because of its high efficiency, is kept in continuous operation, and for emergency use, a 3,000,000-gal. duplex pump of lower efficiency is used, and on this unit the first cost was less than on the high duty pump.

The low service pumps are motor driven and are in duplicate units, consisting of two 3,000,000-gal. units, delivering the water from the intake of the Mississippi River into concrete lined settling basins, from which the water flows through four 750,000-gal. capacity mechanical filter units. Duplicate generating units are provided for generating the electricity for operating the low service pumps and also to furnish power for the operation of the blower and wash water pump used in the water filtration plant and also to furnish electricity for lighting the entire plant and grounds.

In this installation, the equipment was selected so as to make certain the highest obtainable operating efficiency. In operating, all the coal is weighed on permanently installed scales, and the boiler feed water is weighed with an automatic recording device that determines the amount of water evaporated for the quantity of coal used, and a constant check is thus obtained on the amount of steam produced by a given amount of coal. The ability and faithfulness of each fireman is easily learned by an examination of these records. The records are so arranged as to show at a glance the results obtained from day to day throughout the year with reference to the amount of coal consumed, the amount of water evaporated, the amount of water pumped and the cost of fuel per thousand gallons of water pumped. This system of record gives the superintendent a means of checking up from month to month on the performance of the individual firemen, and he can hold them up to a high mark, or replace them.

A new intake was built into the Mississippi River. Its construction was made necessary on account of the building of the Keokuk Dam which had raised the level of the water in the river at Fort Madison about 15 ft. and it was desirable to place the new intake above the bottom of the river in order to avoid drawing in sediment.

Between the low service pumps and the filtration plant all water is metered. This is desirable because centrifugal pumps constantly in operation with water containing sediment lose their efficiency, and a continual check is desired so as to determine when new impellers should be placed in these pumps.

To get an additional check on the wasteage of water, all the water is metered in passing from the high service pump to the steam reservoir and into the mains. This double check on both high and low service delivery enables a prompt de-

termination to be made of the amount of leakage and prompt remedial measures can be adopted when wasteage is detected. The water distribution system comprises two miles of cast iron mains, and universal meterage is being adopted.

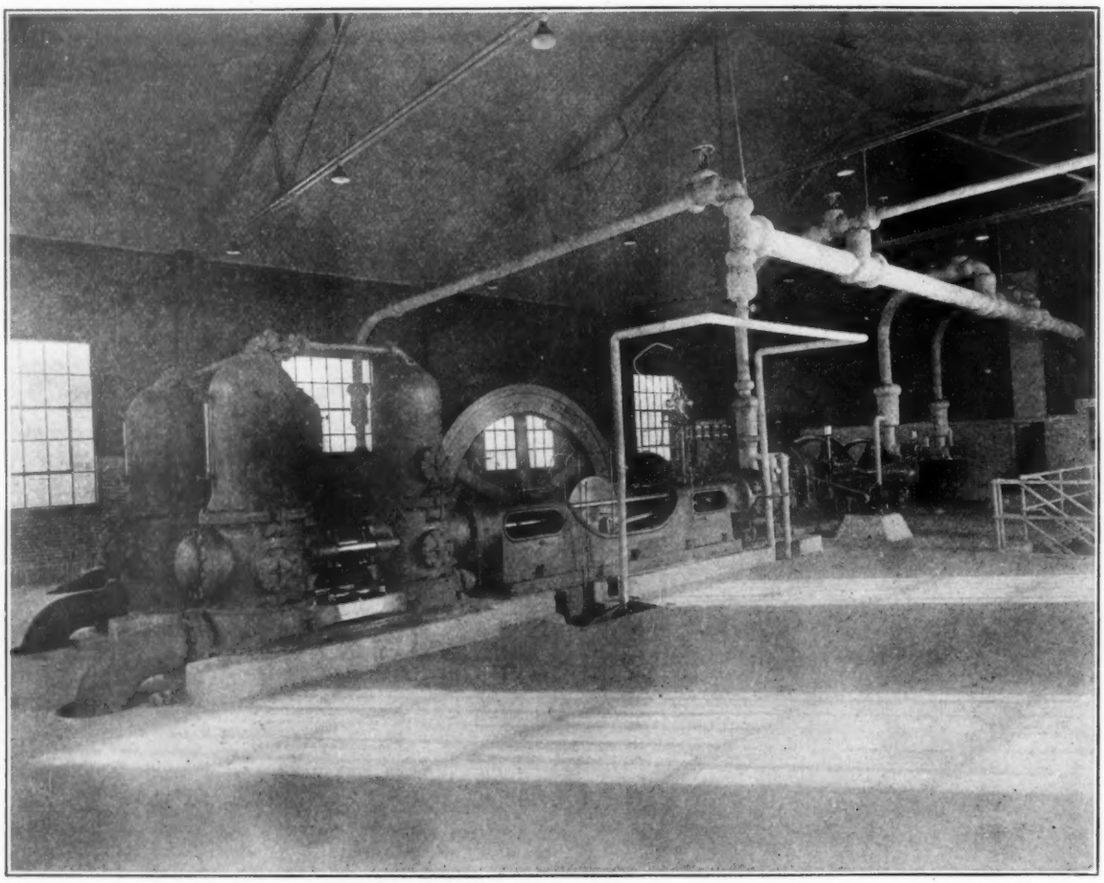
The water purification plant consists of reinforced concrete settling basins and a mixing chamber into which the coagulant is fed with dry feed machines which avoid the trouble of mixing with mechanical solution tanks and the trouble with the agitators in solution tanks. The sulphate of alumina is fed in a pulverized form and goes into solution in the mixing chambers. Storage for chemicals is provided on the third floor of the filter house in carload capacity. Because of the efficiency of the scheme of storage and the dry feed machines employed, the plant is free from the disagreeable odors some times present at a water purification plant.

The concrete settling basin was built on a fill consisting of a creek deposit. Because of this, the settling basin was placed on a large reinforced concrete slab, the reinforcing consisting of about 75 tons of old steel rails Although the basin has been in operation for about a year, measurements recently taken show that the settlement has been less than ⅛ in. This certainly indicates the success of the new slab foundation, as, in addition to the creek deposit at the site, a saw mill once operated on the same site, and a large amount of saw dust remained in the soil underlying the basin, which therefore, did not provide good supporting qualities.

The water flows by gravity from the settling basin into four 750,000-gal. mechanical filter units, installed by the Pittsburgh Filter Manufacturing Company. The filters are in one row. The filter gallery under the filter floor has all its pipes and valves readily accessible to the operator, and provides plenty of head room and working space, with all the piping arranged on one side of the gallery.

Because of the unusual difficulties of construction and the hazardous nature of the undertaking from a contractor's standpoint, this contract was awarded on a cost-plus-a-percentage basis to the Wodrich Construction Company of Minneapolis, Minn. This plan of handling the work proved mutually satisfactory. The pumping and power plant equipment was furnished and installed by the Merkle Machinery Company of Kansas City, Missouri, and much of the installation of this equipment was also erected on a cost-plus-a-percentage basis.

Recent tests of the filtered water by the state chemist, show a reduction of bacteria, amounting to 99¾%. Three separate tests have also been made by the state chemist, who has found no trace of dangerous bacteria or disease germs in the water. The only chemical coagulant now being added to the water is the sulphate of alumina, and because the results are so satisfactory from the hygenic standpoint, the consumption of water has increased rapidly since the new plant was placed in operation some eight months ago. As a further precaution to the water treatment process, liquid chlorine sterilization of the filtered effluent is practiced.



INTERIOR OF PUMP ROOM, FORT MADISON (IOWA) WATER WORKS, SHOWING HIGH SERVICE CORLISS ENGINES.

Seven miles of new pipe lines were added to the distributing system, and by making use of old gate valves, these extensions were installed with but slight interference in various parts of the residental district. Large reinforcing mains were also laid in the business district and a duplicate supply line was installed, connecting the main pump plant with the distributing system in the business district and the new mains were laid by Stephen Schults of Fort Madison, and were placed in service almost as fast as laid, as the corporation desired to secure revenue as each block of extensions was completed.

The entire engineering work, including the preparation of plans, specifications and supervision of construction, was

handled by the firm of Burns & McDonnell, consulting engineers of Kansas City, Mo. Mr. C. E. Painter was supervising engineer on construction, and remained in charge of the operation of the plant.

Use of Condensing Apparatus in Water Works Plants

The Editor of MUNICIPAL ENGINEERING:

Sir—

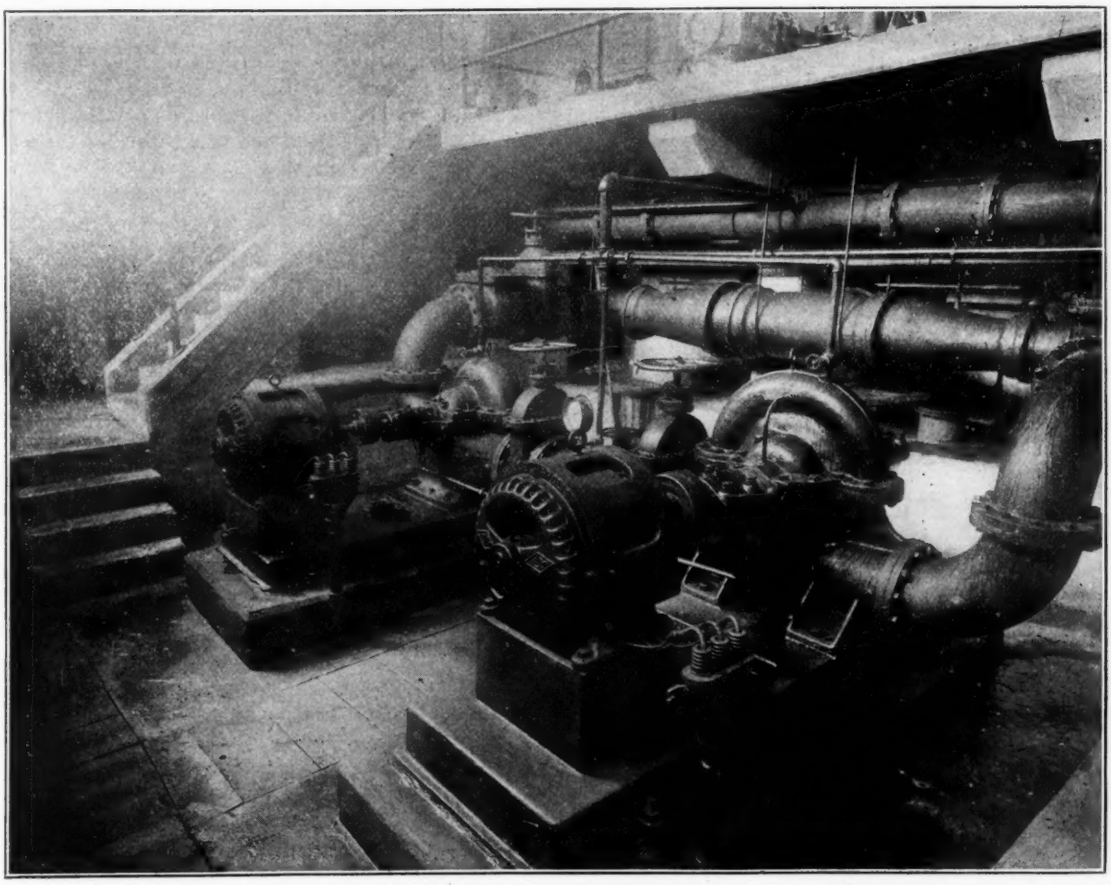
We believe there are few engineers in water works plants who have not carefully studied and in many cases taken advice upon their existing condensing apparatus and the economical possibilities of modifying or improving it. There are many existing plants where the type and design of engine with its valve areas, port areas, etc., would prevent realization of higher economy with improved vacuum.

There can be no question as to the thorough discussion of this feature in the case of the proposed installation of new apparatus, as it must necessarily be carefully considered by any consulting engineer, and would be thoroughly discussed by the builders of pumping apparatus, who would be desirous of utilizing their latest economical improvements to the fullest extent permissible, provided the specifications so permitted.

High Vacuum Obtainable in Water Works Plant

There is one point which is perhaps not sufficiently realized or appreciated, viz: for the same amount of power developed, a water works plant is capable of obtaining much higher vacuum and consequently better economy than any other type of power plant. One of the most serious questions in the selection of a site for a large power plant, especially a lighting or power station, is the availability of sufficient condensing water and the possibility of satisfactory arrangement for its utilization. Smaller power plants must usually be satisfied with a location which they know will not permit of realizing the highest economy. In the commercial power plant, both the quantity of water and the power economically available for handling it are limited.

In the case, however, of a water works installation, a surface condenser can be placed in the suction or discharge main at the point that best conveniences the general layout, and the quantity of water is from 15 to 20 times that available for condensing work in a commercial plant. This means that the temperature of the water passing through the condenser is raised, say, 1 degree instead of 15 to 20 degrees with consequent reduction in the temperature and corresponding pressure in the steam space. In fact, with the same temperature of water, it should be readily possible to maintain .3 to .5 in. better vacuum with the water works type of condenser, which would result in an improved economy or duty of from 3 to 5 per cent. at least.



TWO 3,000,000-GAL. MOTOR-DRIVEN, LOW-SERIVCE PUMPS, FORT MADISON (IOWA) WATER WORKS.
These Pumps Lift Water to Settling Basin, and It Flows by Gravity to Four Mechanical Filter Units.

Results at Sixty-Eighth Street Pumping Station, Chicago

Your readers are familiar with the duty trials of the two 30,000,000-gal. turbine driven centrifugal pumping units recently installed by us at the 68th Street Pumping Station in Chicago, as described in MUNICIPAL ENGINEERING for October, 1917, where a vacuum was maintained corresponding to between 1 and 1.5 ins. absolute at the turbine exhaust nozzle when operating at capacities between 17,000,000 and 42,000,000 GPM. In this plant water from the main was utilized for operating the auxiliaries, thus realizing for that purpose the economy of the main pumping unit itself and requiring at maximum capacity only approximately 1½% of the main turbine power for driving the auxiliaries. In this case, to have met the same guarantee of condenser performance as in the case of a commercial

turbine of the same power, we should have asked for approximatly 1,600 GPM of circulating water instead of the 30,000,000 gal. capacity or approximately 21,000 GPM available in this instance.

The surface is not quite as efficient in heat transmission in the water works type of condenser as in the commercial type, for the reason that in the latter, the water passes uniformly through the tubes and over the surface at a velocity which permits it to carry away the heat efficiently, whereas in the water works type, the water passes in a less efficient manner over the outside of the tubes, which are arranged to cause an inappreciable loss of pumping head.

WORTHINGTON PUMP AND MACHINERY CORPORATION,
May 9, 1918. 115 Broadway, New York.

WATER PURIFICATION AND SEWAGE TREATMENT

The Development of Sewage Treatment

By Kenneth Allen, Sanitary Engineer, Board of Estimate and Apportionment, New York, N. Y.

Review of Past Development

The disposal of human waste is a problem that has confronted cities and towns from times immemorial, but it is only within the past 70 or 80 years—nearly coincident with the introduction of water closets—that sewerage as we now know it, with its problems of disposal, has been a factor in municipal sanitation.

Early Aspects of the Problem

At first it presented itself as a problem of the removal of excretal matter, at first by itself and then together with surface and subsoil water, from the immediate vicinity of habitations; but as water courses became more polluted, secondary nuisances arose impelling action toward their amelioration. In a report of the Royal Sanitary Commission, published in 1875, it was stated that it was the serious outbreaks of cholera in 1831, 1851 and 1866 that "led to investigations of the means of preventing infectious diseases, and so drew attention to the fact that the *seats of endemic diseases are generally where the air or water is polluted.*" And so, with no knowledge at the outstart as to the underlying principles governing the development of nuisances and the dissemination of the germs of disease, progress, though slow and irrational, was being made.

Pioneer Disposal Methods

It was early recognized that sewage had a certain value as a fertilizer; in fact, excreta had been used in this way for centuries, so that sewage farms, especially in England, where ideas of sanitation were most advanced, sprang up; and later, as involving the use of less land, there followed the primary removal of solids by settling in tanks, rendered more effective later by the use of precipitants.

About this time—in the seventies—experiments by Frankland and Bailey Denton in England demonstrated the possibility of sand filtration, followed by the discovery of Schloesing and Muntz, in France, that the purification effected was due to micro-organisms.

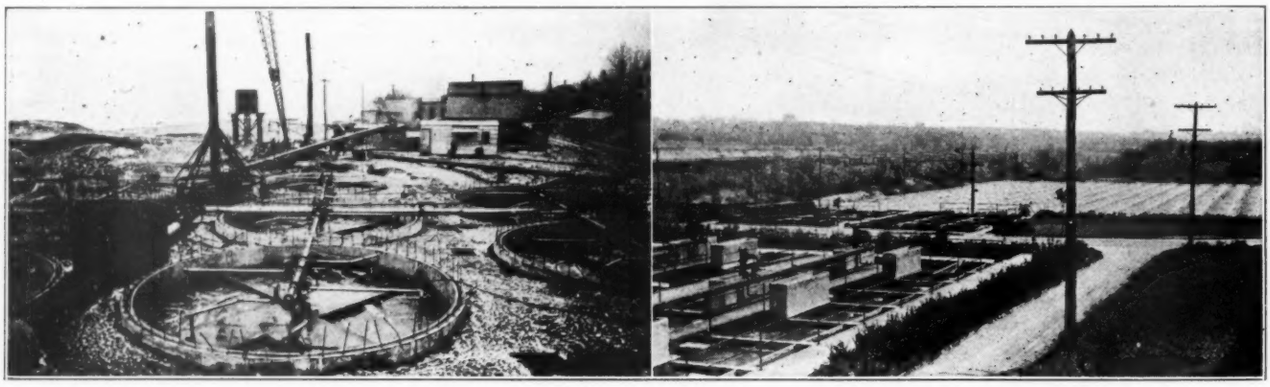
In the eighties, by the investigations of Warrington, Dibdin, Dupre, and last, but not least, the classic experiments of the Massachusetts State Board of Health under the guiding hand of Hiram F. Mills, the true theory of the agency of bacteria in purification was placed on a firm foundation; and from that time progress in sewage disposal has been established on a rational basis.

Anaerobic Decomposition

In 1878 Dr. Muller, of Berlin, obtained patents involving anaerobic decomposition for the wastes from beet sugar factories, and four years later Mouras patented his "automatic scavenger" in France, a device which he had used in his house for 20 years and which was the forerunner of the septic tank of today. But it was not until Cameron built his septic tanks at Exeter, England, in 1895 and 1896, that the principle of getting rid of the organic solids by liquefaction was adopted by a municipality.

In the next 15 years the septic tank was greatly in vogue in England and America, and today it leads the list in the latter country. It is interesting, now that we are so familiar with its limitations, to recall the optimism with which its introduction was first received. At an inquiry of the Local Government Board of Great Britain at Exeter, in 1897, the effluent was described as "a really colorless fluid, free from deleterious properties, and fit to be passed into any river." Dr. Dupre testified that "everything that can be purified is already purified in the septic tank and filtrate and any change must be in the direction of additional purity undoubtedly."

The effluents obtainable from sewage farms and sand filtration areas were such as to meet all reasonable requirements,



LEFT: VIEW OF ACTIVATED SLUDGE AERATING TANKS, MILWAUKEE, WIS. RIGHT: VIEW OF IMHOFF TANKS AND TRICKLING FILTERS AT FITCHBURG, MASS.

but the majority of the plants in England comprised some kind of tank treatment.

Chemicals began to be used for precipitating the solids about 40 years ago, and a large proportion of the English plants today involve chemical precipitation. Over 500 patents have been issued in Great Britain for different precipitation processes, but in the United States the trend in recent years has been more toward the use of septic or Imhoff tanks.

Introduction of Oxidizing Filters

The effluent from all these tank installations, even if clear and sparkling when first discharged, was unstable and putrescible. A remedy for this was found by Dibdin in 1892 by treating the sewage at Barking (London) on contact beds, and the next year by Corbett in treating the sewage at Salford by trickling filters. By each device the dissolved organic matter was reduced to a mineral form and the effluent rendered relatively stable. The theory of these finishing or oxidizing processes had already been well established by the investigations of the Massachusetts State Board of Health mentioned above.

1. To prevent the objectionable appearance of streams;
2. To avoid the formation of sludge deposits;
3. To avoid the production of odors; and,
4. To prevent the dissemination of disease.

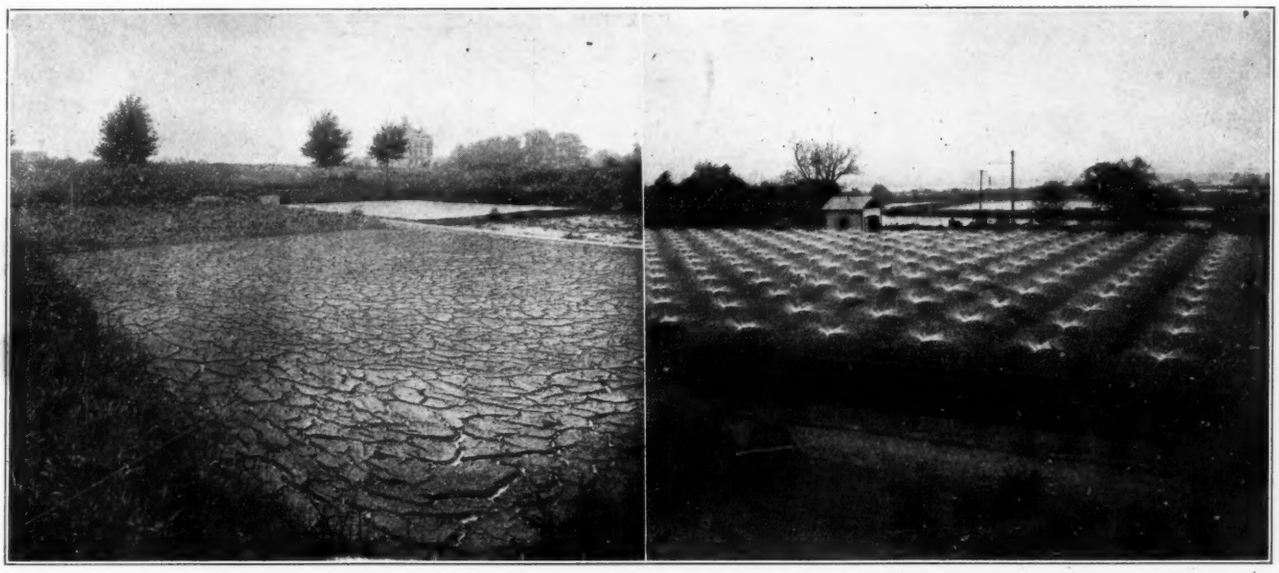
1. To Prevent the Objectionable Appearance of Streams Due to Floating Solids, Scum and Sleek

Scum and sleek are mainly due to the oily constituents of sewage. It is impracticable to avoid entirely the presence of sleek, although both this and scum may be reduced by skimming in a chamber or tank before discharge. The larger floating solids are much more objectionable, and where it is desired merely to remove these the standard operation is fine screening.

Various types of screens have been used, but their chief development has been in Germany. Within the past ten years two types have gained a foothold in the United States, the Weand and the Riensch-Wurl.

The Weand Screen

The Weand screen was first used at Reading, Pa. It consists of a horizontal cylindrical frame covered with a mesh of monel metal having about 36 strands per inch. The sewage enters one end, and, as the screen rotates, flows through the mesh, leaving the screenings inside to be automatically worked toward the farther end and removed through a chute. These screens have been installed, besides at Reading, Pa., at Baltimore, Md., Atlanta, Ga., and Brockton, Mass., in each case as preliminary to further treatment.



VIEWS OF SLUDGE DRYING BEDS AND TRICKLING FILTERS IN OPERATION, PHILADELPHIA, PA., SEWAGE TREATMENT WORKS.

The next important step forward was in modifying tank treatment so as to subject the sludge only to septic treatment allowing the sewage to pass through with a brief detention, as worked out by Travis in England in 1908 and Imhoff in Germany the following year.

Disinfection of Sewage Effluents

The effluent from all of these processes was a source of danger if introduced into water supplies, so that in 1905 Johnson and Copeland made tests at Columbus in the use of copper sulphate as a disinfectant. These were followed in 1907 by the use of bleach by Phelps at Red Bank, N. J., and up to the present time chlorine as bleach or in the liquid form has been used successfully for the disinfection of water supplies or sewage effluents by many towns.

These improvements were the last of a fundamental character to be adopted and established in standard practice up to the present time; but there have been several recent attempts to achieve more perfect results that are sufficiently important and promising to deserve mention.

Standard Methods of Sewage Treatment

With this brief review of the development of sewage disposal in the past we may clarify our ideas of the subject by considering categorically the chief reasons for treating sewage, with the methods most commonly employed:

The Riensch-Wurl Screen

The Riensch-Wurl screen, brought into prominence by the excellent installation at Dresden, is employed in some 50 European plants, and within the past few years has been installed at Rochester, N. Y., Johnstown, Pa., Long Beach, Cal., Brooklyn, N. Y., and, during the past year, at Dyckman street, Manhattan. It consists of a bronze plate rotating on an axle usually inclined 15 or 20 degs. from the vertical, and surmounted by a truncated cone of the same metal. The plate and cone are perforated with slots, which, in the Dresden screen, are .08 in. by 1.20 in. in size. The sewage covers and passes through the lower part of the screen, and as it rotates it is kept clean by brushes which remove the screenings to a receptacle or conveyor.

Nearly all the visible solids and from 15 to 30 per cent. of the total suspended solids may be removed by fine screening, so that the effluent is not only less objectionable in appear-

ance, but is in a much more favorable condition for oxidation by the stream to which it is discharged or by any process of filtration.

2. To Avoid the Formation of Sludge Deposits, with Their Resulting Odors and the Necessity of Dredging

This is accomplished by settling, first in grit chambers, to remove the sand and heavier solids, and then in tanks, to remove the finer solids. The theory of rational tank design is admirably described in *Annales des Ponts et Chausses* for January-February, 1917, by H. Verriere, supported by the results of the Mont Mesly Experiment Station at Paris. Verriere concludes that horizontal tanks, with a length of from 4 to 12 times the width, should have a sump at the influent end and then a depth of from 5 to 10 ft., sloping upward to about 3 ft. less at the farther end. Such tanks will care for about 200 gals. per day for each cubic foot of volume.

Septic tanks, in which the sludge is digested, should be about twice as deep, or 20 ft. instead of 10 ft., near the influent, to provide storage for the sludge. These are more costly to build, but, as there is less sludge to handle, they are less expensive to operate. Operation is not, however, always satisfactory, as there is greater probability of odor than with fresh sludge.

Vertical, or, as we usually call them, "Dortmund," tanks occupy but one-third, or at most two-thirds, the space required for horizontal tanks, but are more costly, due to their depth. Seven and one-half feet is found a sufficient distance for the sewage to flow upward in the tank at a rate of about .05 or 0.1 ft. per minute, though rates from two to four times these are frequently used. Sludge storage should be provided in the pyramidal or "hopper" bottom for five days' accumulation. Tanks of this description will treat 65 to 130 gals. daily for each cubic foot capacity, including the hopper.

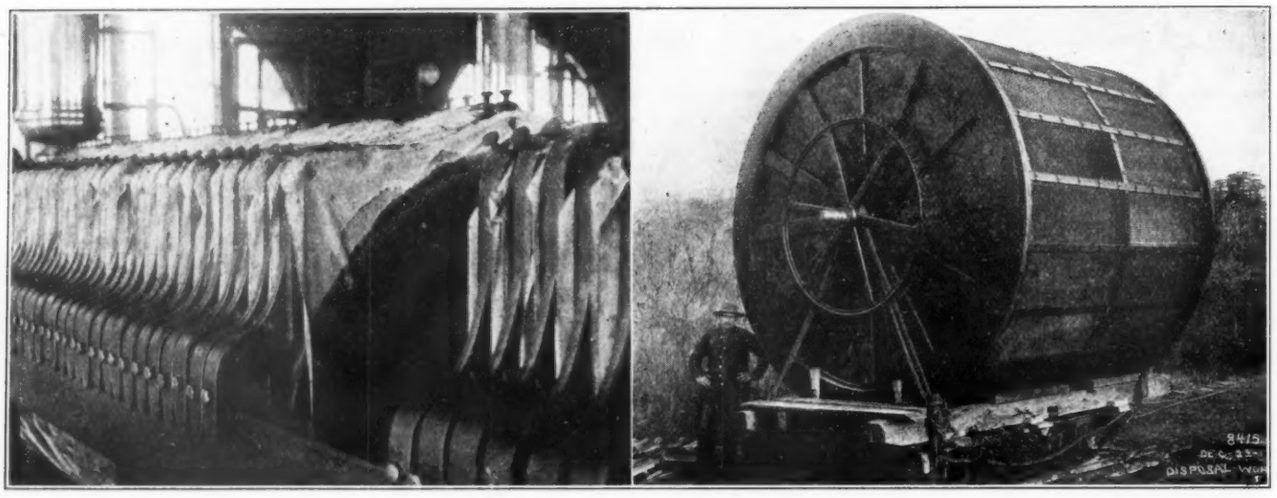
The Imhoff tank is merely a modified form of a septic tank, but with a separate chamber for the sludge, capable of storing it for from four to eight months. It is, therefore, yet more costly, but provides greater security from odor than either the septic or Dortmund tank.

Now either of these types of tank will remove at least 40 to 60 per cent. of the total solids with good operation, and if higher efficiencies are required chemical precipitants may be employed, usually with the horizontal type of tank. By this means a removal of 70 to 80 per cent. is practicable, and the effluent is free from turbidity, though often colored.

Unless some of the solids in solution are thrown down by the salts contained in the body of water to which it is discharged, the danger of sludge deposits is avoided, but if the supply of oxygen in the stream is sufficient, there remains the danger of subsequent putrefaction, with its evolution of foul gases.

3. To Avoid the Production of Odors in the Stream Receiving the Effluent

Contrary to common opinion, fresh sewage has no strong or particularly disagreeable odor if dissociated from the idea of its origin. But when it becomes septic—that is, when it has used up the available supply of oxygen which it contains—it turns black with the production of foul gases. In other words, oxidation gives way to putrefaction, and these conditions result in odors due largely to sulphureted hydrogen and other more complex compounds of sulphur. The obvious remedy is to maintain a supply of oxygen, so that decomposition may take place on an aerobic instead of an anaerobic basis, and this is accomplished either by dilution with a sufficient volume of water already supplied with dissolved oxygen or by some method of filtration whereby oxidation is promoted. In either case the actual change, mainly brought about through the agency of nitrifying bacteria—that is, bacteria which oxidize the ammonia compounds in the sewage to the more stable form of nitrates. In this form the nitrogen is available for plant food and the oxygen is available as a reserve that may be drawn on for the oxidation of organic matter.



LEFT: SLUDGE PRESSES, WORCESTER, MASS., SEWAGE TREATMENT WORKS. RIGHT: VIEW OF WEAND SEWAGE SCREEN AT BALTIMORE, MD., BEFORE ERECTION.

Irrigation and sand filtration are common modes of oxidizing liquid wastes, but the typical process now employed in sewage disposal practice is by trickling filters.

Trickling filters, which are usually composed of a bed of broken stone 1 in. to 2½ in. in size and 7 or 8 ft. deep, permit the gradual percolation of sewage over the surfaces of the stones in such a way that it is rapidly oxidized by the gelatinous bacterial film which forms on them after a few weeks' use, becoming in this way stable—that is, free from the tendency to putrefy and give off bad odors.

4. To Prevent Dissemination of Disease

Sewage necessarily contains the germs of typhoid, tuberculosis and many other diseases, and where the effluent is liable to find its way to sources of water supply or to beds on which shell fish are cultivated, it is desirable to eliminate these germs, for even the more thorough processes of oxidation furnish no guaranty of their absence.

The standard method of disinfection or an approach to absolute sterilization is in dosing the effluent, after freeing it from the larger particles of suspended matter by screens or tanks, with from 3 to 10 parts per million of liquid chlorine and allowing them to remain in contact for an hour or so. The effluent is this way freed from 96, 97 or perhaps more

than 99 per cent. of the contained bacteria, including those which produce disease.

Complete treatment, according to the standard American practice of today, comprises, therefore:

Sedimentation in tanks with or without fine screening;
Oxidation by trickling filters;
Disinfection with chlorine.

Recent and Future Development

Recent development in sewage treatment has been, if we disregard the question of sludge handling, rather along the lines of improvement of well-established procedure than in radical innovation.

Fine Screening

The recommendation of fine screening for certain situations by engineers of standing, combined with the placing of the Riensch-Wurl screen on the market by an American manufacturer, has given a certain impetus to this method of treatment. Much information is yet lacking regarding the cost and efficiency of these machines with American sewages and operation, but from now on this should be increasingly available. On the whole it seems probable that fine screening will be adopted more and more by our seaboard and lake cities and those located on large rivers, in order to satisfy aesthetic demands.

Notable examples are the cities of Cleveland, where fine screens are to be employed at the new West Fifty-eighth street plant, probably Indianapolis, and New York, where, in addition to the Dyckman street and Twenty-sixth Ward plants, they are proposed at West Forty-sixth and East Forty-first streets, Manhattan, and at Theodore street and for the Rockaways, in Queens.

Settling Tanks

In the design of settling tanks progress appears to be more in the nature of refinements in proportions, baffling and the method of receiving and discharging the sewage and drawing the sludge. As an example may be mentioned a tank of three separate chambers designed by J. W. Alvord for the Great Lakes Naval Training Station. The essential features comprised are hopper bottoms for the withdrawal by gravity of sludge from the two outer tanks to the middle or sludge tank and from the latter for disposal; the withdrawal of effluent from one outer tank to the other and from the latter for disposal, from the stratum of optimum clarification lying below the scum. It also involves the withdrawal of the scum itself from the outer tank receiving the raw sewage and its delivery to the sludge tank. The effluent is claimed to be of exceptional clarity.

The tendency for several years has been to limit the period of retention to that required to remove a reasonable proportion of the settleable solids—say 80 or 90 per cent.—rather than to attempt an unreasonable—that is, uneconomical—efficiency regarding the total suspended matter.

As to the tanks, although the septic tank is the type most commonly found in this country, it is being gradually supplanted by the two-story Imhoff tank in new installations. This perhaps is due chiefly to the ineradicable defect in the quality of the effluent, which is ill-smelling and turbid. Nevertheless, some of the better examples are giving satisfaction, and now, on account of their simple construction and low cost, and in order to avoid the objection attending scum formation, to be anticipated with fresh domestic sewage in Imhoff tanks, they have been adopted as the standard for our army cantonments.

Chemical Precipitation

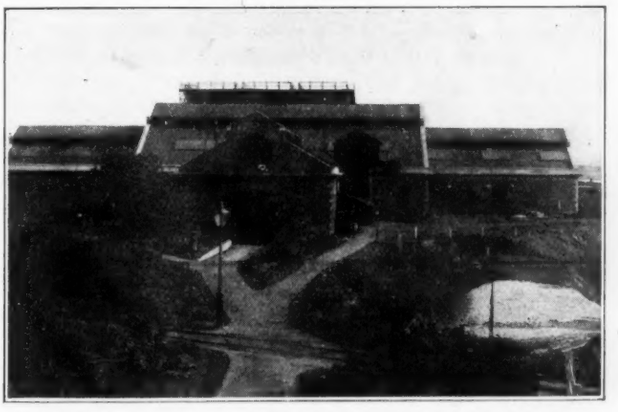
Chemical precipitation with lime, alum or copperas shows no indication of a revival, although in certain situations, especially in connection with industrial wastes, it will probably continue to be found advantageous. A strong point in its favor lies in its effective removal of the readily decomposable colloids. Excellent examples remain at Worcester and Providence, but the four antiquated plants in Brooklyn and Queens have outlived their usefulness and should be turned to better use or abandoned.

But precipitation involving the use of sulphuric acid (or perhaps sulphur dioxide) to concentrate and separate the solids and grease, as employed at Bradford and Oldham, England, and as patented here as the Miles process, has some distinct advantages, and may on further investigation prove worthy of serious consideration as a means of recovering grease and fertilizer. The process is said to be inodorous and the effluent nearly sterile.

Tank Design

In tank design it is believed the vertical type will grow in favor where the depth does not make the cost too great, for the efficiency of such tanks is high, and they lend themselves more readily to the automatic removal of sludge without interruption to the process of sedimentation .

If the sludge is to be digested, the Imhoff tank appears to satisfy most conditions. Experience tends to favor a more



GENERAL VIEW OF LONDON CHEMICAL PRECIPITATION WORKS AT BARKING.
Workshop (Gable in front), Main Engine House (in rear), and Boiler Houses (on flanks).

liberal capacity of the sludge chamber, horizontal rather than radial flowing through chambers, greater attention to the suppression and removal of scum where this is troublesome, and the prevention of the accumulation of the products of septic decomposition in sludge pockets by a movement of their contents by drawing off sludge, by the introduction of a small amount of water or sewage through a jet or by mechanical stirring.

Separate Sludge Digestion

Experiments with separate digestion chambers have been made at different times and places. At Birmingham, England, and Baltimore the fresh sludge has been stored in open tanks, apparently without objectionable results, but it is probable that a safer plan is to prevent exposure to the air and promote intensive septic decomposition. This was being tried out at Elberfeld, Germany, when visited five years ago, and has been experimented with at the Twenty-sixth Ward plant in Brooklyn and elsewhere, with, it is believed, satisfactory results; but no general conclusions appear to have been arrived at as to the merits of this practice. In some situations the cost of installing deep tanks would be greatly reduced.

Pumping Sludge to Central Plant

A further step has been suggested as an economy in the handling of sludge from a series of plants in pumping to some central point for storage, and, possibly, drying and the recovery of by-products. The pumping of sludge for distances of four or five miles is successfully carried out at Birmingham, Bradford and Glasgow, and where the expense of constructing and operating independent sludge treatment plants, and especially if the construction of a costly intercepting

sewer, can be avoided, the plan of establishing a central sludge plant has much in its favor.

Activated Sludge Process

Among oxidizing processes the activated sludge process has received the greatest amount of attention for the past two or three years. Owing to the war, development in England, where it was first put in practice, has been hampered, but to the several plants already in operation there is to be added one at Manchester. In this country, although at least seven plants have been installed, there is a great deal to be done in the way of standardizing methods. Valuable data have been secured at Milwaukee by Hatton and Copeland, at Urbana by Bartow, and in the sanitary district of Chicago by Pearse, resulting in progressive improvements. For instance, the removal of the coarser particles by grit chambers and sometimes by fine screens before activation has been shown to reduce the volume of air required. But tank details, type of diffuser, optimum air volumes and pressures and periods of detention are matters yet to be standardized for general practice, and will always vary with local conditions. As a test of the effluent the determination of the albuminoid ammonia has been found most indicative at Pasadena. If less than 2 p.p.m., the effluent is said to have a stability over 99.

On the whole, it would appear that the advantages of the activated sludge process lie in the small space required—one-third or one-fourth that for a trickling filter plant—and in the recovery of fertilizer in the sludge. But as the question of space is often of little importance, as the plant is expensive and the operation one requiring a high degree of intelligence and skill, and, further, as the value of the by-products depends upon the quality of the sewage, it may as well be conceded that the outlook for its adoption by small towns is not bright and that no city should undertake to install the system without thorough preliminary investigation and expert advice.

The handling and disposal of sludge always co-exist with tank treatment. Activated sludge has been found so offensive when left to dry out in the air that some form of de-watering is obligatory. Preliminary concentration by a Dorr thickener has been used at Milwaukee, and this brings up the possible advantage in removing sludge in plain sedimentation plants from the bottom of large shallow tanks by rotary scrapers or some other device, especially where the cost of rock excavation for deep tanks is high. The relative advantage of further de-watering to 75 per cent. moisture Berrigan, Kelly and Sweetland presses, instead of the usual plate filter press, have been partially tried out, and it is hoped that more definite conclusions than are now available may be arrived at within the next year or two.

The Miles Process

Aside from the activated sludge process, the Miles process, already mentioned, has attracted more attention than any other in relation to the recovery of by-products. By the use of sulphur dioxide, which may be obtained from niter cake, the grease, including that from soaps, separates out with the sludge, and, after recovering this by percolation, the degreased sludge has a certain value as fertilizer base. Experiments have indicated a material net revenue possible from the Boston sewage collected at Moon Island of from $200,000 to $400,000 per annum, based upon a flow of 100 m.g.d. and pre-war prices for grease. Under present conditions the revenue from grease would be four times and that from fertilizer over 2½ times the corresponding figures before the war. Efforts have been made to provide for a trial of the process on a large scale, but as yet without success. So much has been expected and so little accomplished in a commercial way from sludge that much conservative opposition must be overcome, but as time passes the prospect of a moderate success in this line, where conditions are favorable, seems to improve.

It may be of interest to mention that at Wolverhampton, England, wet activated sludge has been successfully used as a fertilizer by irrigation.

With the treatment of tank effluents nothing notable is to be recorded in the recent past except the possibility of rapid mechanical filtration with a high-grade tank effluent, as is being used by Mr. Alvord at the Great Lakes Naval Training Station, already referred to. The results will be looked for with interest.

Disinfection with chlorine has become well established as a prophylactic measure in connection with water supplies, and to a less extent with sewage effluents.

A new disinfectant, known as "chloramid" (NH_2Cl), is said to offer an economical advantage in its selective action on bacteria, chlorine being partially used up on the other organic matter in the sewage.

Summary

To sum up, progress in sewage disposal during the past year has been rather in the development of established processes and a refinement of design rather than in any marked innovation.

In particular there has been a moderate increase in the use of fine screening, which promises to continue, and the septic tank has enjoyed a certain revival in its use for army can-

VIEW OF RIENSCH WURL SEWAGE SCREEN IN OPERATION AT DRESDEN.

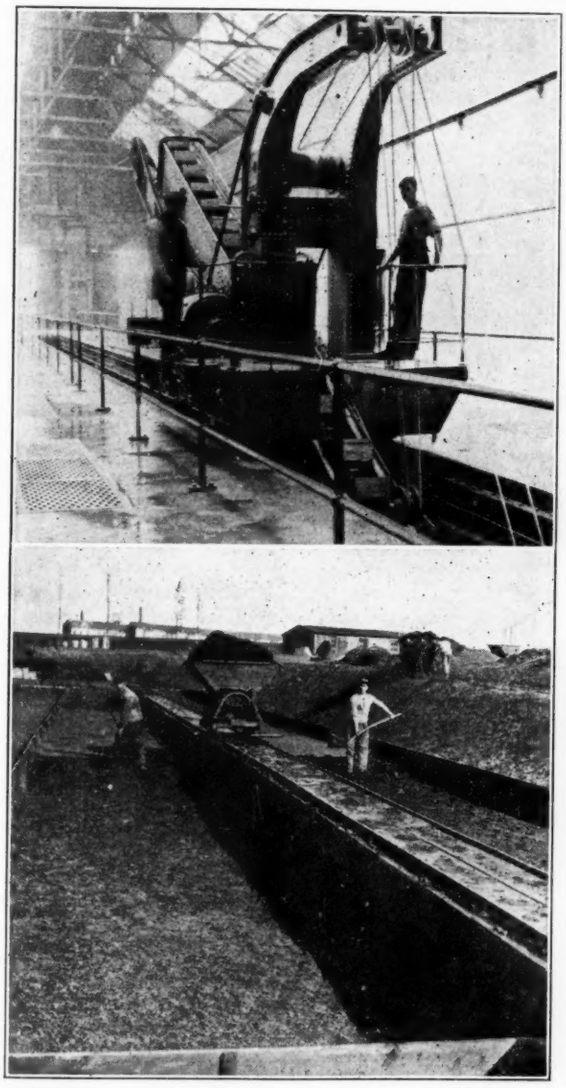
tonments. A large addition has been made to our information regarding the activated sludge process, but there are several important details which remain in the experimental stage, and until these are determined there will remain some question as to the applicability of this treatment.

Progress in sludge treatment has perhaps been of more importance than that of sewage alone. Before the war the price of fertilizers had risen, owing in part to the natural increase in demand and in part to the decrease in the output of manure following the introduction of motor vehicles. The theoretical loss of nitrogen has long been recognized. According to Sir William Crookes, the United Kingdom disposed of this in the sea to the extent of $78,000,000 per annum. And in addition there is the grease, which, in many sewages, outweighs the nitrogen in value. Now, owing to the war, the demand for both of these has increased and is increasing enormously. Greater attention has been directed to their conservation by garbage reduction than before, and now the activated sludge and the Miles processes are two possible methods available for utilizing sewage sludge with apparent profit. Both of these have received increased attention during the past year, and, especially in methods of concentration and drying, definite progress is anticipated in the near future.

Owing to the unstabilizing effect of the war on values, questions of sewage disposal are subject to a searching realignment. Sewages near munition works have changed in character and amount; labor is more difficult to secure; en-

gineers and chemists have been largely diverted to other fields of employment; prices of metals and chemicals have soared upward, and attention, for the time, is directed to other more important ends. Nevertheless, for the comfort as well as the general sanitary well-being of the community, sewage disposal problems should not be neglected, but should rather be studied and solved with even greater regard to efficiency than ever.

Finally, there has been a marked movement for several years past toward a more rational attitude regarding the goal to be aimed at in sewage treatment. Former rigid and often unreasonable requirements as to effluents, regardless of the conditions attending their discharge, are giving way to a



UPPER: INTERIOR VIEW OF GRIT CHAMBER, GLASGOW, SCOTLAND, SEWAGE WORKS. LOWER: REMOVING SLUDGE FROM DRYING BEDS, ESSEN, SEWAGE WORKS.

search for the best way to attain the degree of purification required by the particular case in hand. Careful studies of mimimum stream flow, the dissolved oxygen available in the water and the rapid diffusion of the effluent, as well as the character of the sewage as to settleable solids, organic matters in the colloidal as well as the solid form and in solution, amount of fats, age and oxygen demand, are all recognized as of importance in deciding on the mode of treatment. And having in view the object sought—whether to prevent deposits, or odors, the destruction of fish life, or merely to preserve a decent appearance in the stream—the means to realize the end should be the one that will be found not only the most economical, but the one most generally acceptable from every point of view to those living near the plant, to the riparian owner and to the taxpayer.

Some Results Secured by Chlorine Compounds in Water Purification and Sewage Treatment

By C. A. Jennings, Sanitary Engineer, People's Gas Bldg., Chicago, Ill.

Less than ten years ago, hypochlorite of lime was used for the first time on a large scale for the disinfection of a water supply. Previous to this it had been used in large quantities to prevent the spread of typhoid fever from polluted water supplies, but no attempt had been made so to treat a polluted water that disease producing organisms would be eliminated and yet the water would remain unchanged in taste and odor. In these ten years, the uses of chlorine compounds in sanitary science has grown tremendously. As would be expected, because of such a rapid growth, the use of these substances has come into bad repute in some instances. Sometimes this has been due to the fact that over-zealous people expected more of the treatment than could be accomplished and sometimes it has been because water companies or departments attempted to accomplish with chlorine compounds work which called for clarification in conjunction with disinfection. Things have adjusted themselves very satisfactorily by this time and filtration has its place, decolorization its place, iron removal its place, chlorination its place and so on. Some problems require for solution a combination of several methods of purification, said Mr. Jennings, in addressing the Southwestern Water Works Association.

Used as Finishing Treatment

It was in 1908 that the epoch-making work was done at the Bubbly Creek filtration plant at the Chicago Union Stock Yards by Mr. Geo. A. Johnson, using hypochlorite of lime to make potable a grossly polluted water in conjunction with a rapid sand filtration plant. Previous to this it had been considered sufficient to remove 97% of the bacteria by purification processes. Since that time however, filtration plants in nearly every instance, use chlorine compounds as a finishing treatment. By the process of filtration, bacteria are removed mechanically. An average of 97% to 98% of the total bacteria can be removed by this process. Chlorine compounds are used as a finishing treatment because they seemingly have a selective action for the organisms that cause disease. The quantities required are very small. Every new filtration plant that is modern, will be found to be equipped with a liquid chlorine apparatus for sterilizing the filtered water. Examples of this are: Kansas City and Emporia, Kan., Tulsa and Guthrie, Okla., Fort Worth and Dallas, Tex., Cleveland and Cincinnati, Ohio, Baltimore, Md., Louisville, Ky., and Indianapolis, Ind.

Reasons for Popularity of Chlorine in Liquid Form

Whereas hypochlorite of lime was formerly used entirely for the disinfection of water and sewage, now it has been almost entirely replaced by liquid chlorine treatment. The reasons for this are many, viz: Hypochlorite of lime or "hypo," is a loose compound of lime and chlorine gas, in other words, the lime serving as a carrier for the chlorine gas. Moisture and carbonic acid in the air, cause this loose compound to deteriorate by giving off chlorine. Shipment is made in wood and sheet iron drums, which are likely to disintegrate. The strength of the hypo decreases rapidly upon exposure to the air. There is considerable loss to the material by being weighed out and being made up into a solution and there is a great deal of undesirable nuisance connected with this operation. Accurate readings must be made of the amount of solution being applied. Orifices and solution feed lines clog up with undissolved material in the solution.

Chlorine Compounds Compared

Liquid chlorine or compressed chlorine gas, is shipped in steel cylinders holding 100 and 150 lbs. each. These are similar in appearance and construction to ammonia, oxygen, and carbonic acid cylinders. At room temperature the pressure on a full cylinder of chlorine is about 90 lbs. Being under pressure, there is no loss in the strength of the substance. In order to liquify the gas, it is necessary to rid it of its impurities and so it will average over 99.8% pure chlorine as used from the cylinders. In the use of liquid chlorine for the disinfection of water and sewage it has been found that the ratio between the amount of hypo to the amount of chlorine to accomplish similar results is about 6:1, with a minimum of 3:1 and a maximum of 10:1. These ratios depend upon the strength of the hypochlorite in the solid form, upon the care with which a solution is made of the hypo in the water and upon the care with which the solution is applied to the water. The ease of operation, especially the direct reading of the amount of sterilizing agent being used, lends itself to more accurate control and more consistent results than could be obtained by the use of hypochlorite. Tastes and odors are seldom met with in supplies treated with liquid chlorine. Milwaukee, Wis., effected a saving of $2,200 in one year on labor alone by the use of liquid chlorine instead of hypochlorite. An appreciable saving was effected also in the chemicals used in favor of liquid chlorine. Minneapolis, Minn., saved $1,800 the first year of operation with liquid chlorine instead of hypochlorite, all of which saving was in the cost of the chemicals. In addition to this there was a saving in labor. The average cost of disinfection with liquid chlorine during 1917 was 37 cts. per million gals. In more than two years, there have been no complaints of tastes and odors resulting from this treatment. At the present time there are probably 1,200 cities in this country using chlorine compounds for the disinfection of water and sewage. Of these, possibly 300 are still using hypo and the others are using liquid chlorine.

Little Prejudice Against Chlorination Now

The former prejudice against "doping the water supply" with a "foul-smelling chemical," has almost died out. This has come about through the successful treatment of water supplies, in most instances, without any production of odors or tastes, through the wonderful reduction in the typhoid fever death rate and through the winning over of the health officers and other members of the medical profession to an understanding of what this treatment could and would accomplish.

There was a time not so long ago, when as a result of a report submitted by a committee composed mostly of Washing members of the medical profession, Congress decreed that no coagulating or other chemicals could be used in the purification of the water supply of Washington, D. C. Today, the water supplies of most of the government cantonments, construction camps, ship building yards, etc., are treated with liquid chlorine in addition to the fact that the soldiers and sailors are all vaccinated against typhoid fever and in most of the camps, the water is obtained from underground sources. Practically half of the state boards of health of this country are supplied with a portable emergency chlorine control apparatus weighing 40 lbs., mounted in a carrying case which is shipped out to municipalities in the event of a sudden typhoid fever epidemic or scare. Such measures make for expedition, increase the confidence of cities in the aims and assistance of state health departments and help lower the typhoid fever death rates of cities by giving prompt and efficient control of emergency conditions.

Disinfection of Water Supplies

Liquid chlorine is used in the disinfection of all types of water supplies, viz: Water obtained from rivers, lakes, impounded supplies, shallow and deep wells, filter galleries, filtration systems, etc. Mountain streams, impounded supplies and well waters are no longer considered safe because they are obtained from the mountains, storage reservoirs and the ground. There are too many contaminating influences to be considered. The Chicago Bureau of Public Efficiency in its report on the Water Works of Chicago, states that "a water supply contaminated on four or five days in a year, may result in serious epidemics." Many cities have learned that liquid chlorine is a safe, cheap and reliable form of health insurance. The manager or superintendent of a water plant, who uses liquid chlorine treatment, does not have to lie awake at night fearful of the quality of his water supply.

The city of South Bend, Ind., obtains its water from deep wells. The U. S. Public Health Service analyzed the water during the summer of 1917 and found B. Coli present. Disinfection was ordered to be installed at once. This was done. It was found that the water coming from the wells was pure. The water being pumped from the storage reservoir was polluted. The chlorine was applied to the suction of the high duty pumps—beyond the last possible point of contamination. Then steps were taken to remedy the condition causing the contamination to the reservoir.

A small city in Michigan derived its supply from wells. The State Board of Health discovered a cross-connection with a pipe leading from the river. Chlorination was ordered to be installed at such a point that whether the cross connection was open or not, all of the water would be treated with liquid chlorine.

Chlorination of Well Waters

Many cities having supplies from underground sources have conditions similar to those at South Bend and frequently have epidemics of intestinal disorders in their cities. Because a water comes from a deep well is no criterion of its purity as it is supplied to the consumer if proper precautions are not taken to prevent its contamination. Frequent analyses of all water supplies should be made. Given the proper conditions, a spring, deep well, or other originally pure water can and will become contaminated as quickly as a surface water.

Liquid chlorine is now being used in many of the government hospital camps in this country and abroad, for the preparation of the Carrel-Dakin solution, which is used in the treatment of wounds.

A recent use for liquid chlorine has come to the notice of the writer. An Illinois city having a deep well supply that has an iron content of 2 parts per million, aerates and filters the water to remove the iron. Recently considerable difficulty has been experienced due to the growth of crenothrix in the storage reservoir and distributing mains. Liquid chlorine is being used for killing this organism because copper sulphate treatment has been unsuccessful.

Chlorination of Trade Wastes

Tanneries discharge liquid wastes carrying the Anthrax organism. This germ is what is known as a spore former and it is very difficult to kill it. The U. S. Bureau of Animal Industry has recently issued regulations governing the treatment of these wastes with liquid chlorine.

Packing houses discharge liquid wastes that have very disagreeable odors. Recent experiments on a large scale in a packing house indicate that it is possible so to treat these wastes with liquid chlorine that the odors will be rendered practically unnoticeable.

By means of liquid chlorine treatment many other kinds of trade wastes can be successfully disinfected and the odor reduced to a point where no nuisance will be committed.

Sanitation of Swimming Pools

Little thought has been given by the layman to the gross contamination that results from the use of the average swimming pool. The shower bath that is made a preliminary to the swim at most pools is usually a sham and does little good. A pool is certain to become highly polluted as a result of bathers using it. The modern method of keeping a swimming pool in a sanitary condition is to pump from the pool water at a

rate sufficient to empty the pool in 18 to 24 hours. This water is forced through a pressure filter to clarify it and then it is sterilized with liquid chlorine and returned to the pool. In this manner a definite amount of polluted water is withdrawn from the pool and the same quantity of pure water returned to the pool continuously. No heating of the water is necessary in this purification process as the water remains at the temperature of the pool.

Liquid Chlorine in Sewage Treatment

Liquid chlorine is used as an adjunct to various methods of sewage treatment. The City of Cleveland, Ohio is to install fine screens to clarify the city sewage and these screens will be followed by liquid chlorine disinfection. At many of the government camps, the sewage is sterilized by liquid chlorine following treatment by septic tanks, filters and other systems. The amount of chlorine required is much greater than in the case of water purification and varies from 40 to 90 lbs. per million gals. depending upon the character of the sewage and the degree of purification desired.

Specific Examples of Successful Chlorination of Water Supplies

As an example of what can be accomplished by chlorination of the water supply, the case of the City of Chicago offers excellent proof. Previous to 1900, all of the sewage of the city found its way into Lake Michigan, from which the water supply is taken. In 1900 the Chicago Drainage Canal was opened, which served as a method of disposing of the greater portion of the sewage. The Chicago River, formerly flowing into the lake, was reversed and was made to flow in the opposite direction, carrying with it the city sewage and a definite quantity of lake water for dilution purposes. As time went on, more and more sewage was diverted from the lake and control was exercised over the dumping of dredgings in the lake, discharge of lake boat toilets in the vicinity of the water intake cribs and other similar sanitary measures. The curve showing the typhoid fever death rate of Chicago is remarkable because it shows what the above mentioned measures accomplished and it demonstrates what partial and what entire disinfection of the water supply will accomplish. Chlorine disinfection was in use at some of the pumping stations during the period 1911-1916, but during 1917 all of the water pumped by the nine stations was chlorinated. The drop in the typhoid fever death rate from 5.2 to 1.7 is wonderful. During 1917 only one sample of water out of 1,779 samples collected for analysis or .06%, showed the presence of B. Coli in 1 cc. B. Coli was present in 5.4% of the 10 cc. portions tested. In 1916 there were 135 deaths from typhoid fever and 1917 only 43.

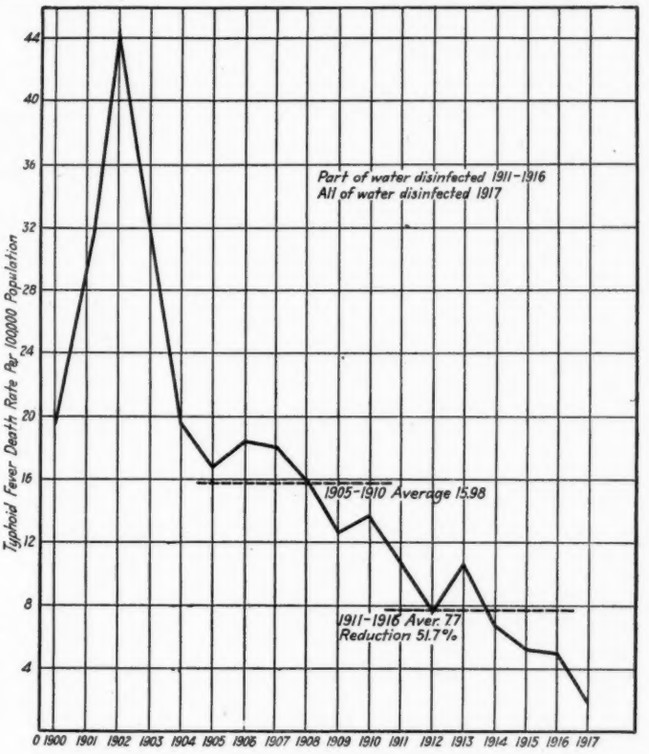
Baltimore's water supply is derived from lakes. Previous to the use of chlorination, the average typhoid fever death rate for the period 1907-1910 inclusive, was 35.38. Hypochlorite treatment was begun in June, 1911. For the years 1912-1915 inclusive, the rate was 23.13, or a reduction of 34.6%. In September, 1915, a filtration plant was put into service and a further drop resulted in the typhoid fever death rate. Liquid chlorine was substituted in 1916 for hypochlorite of lime.

Jersey City was one of the first cities to adopt chlorination of the water supply, beginning the treatment in September, 1908. The average rate for the years 1900-1907 inclusive, was 18.7. For the period 1909-1917 inclusive, the average rate was only 7.3, or a reduction of 60%—truly a remarkable showing for water disinfection. The change from hypochlorite to liquid chlorine was made in February, 1913.

Hypochlorite treatment in Detroit was begun in March, 1913, and the change to liquid chlorine was made three years later, March, 1916. The average rate before chlorination was 19.25 and after chlorination 15.05 per 100,000, a reduction of 21.8%.

Waukegan, Illinois, is one of the many cities drawing its water supply from the Great Lakes which were forced to install water disinfection because of the large amount of typhoid fever. The treatment was begun in April, 1912. Data are available only for the period from 1911 to the present time. Wonderful results were obtained. In 1911 there were 14 deaths from typhoid fever and in 1912 there were 20. The next year there were only two deaths, then for two years there were no deaths, and then three and six respectively, for the two following years. In other words for the entire period of five years since water disinfection was begun there have been only eleven deaths from typhoid fever. The water supply at Waukegan should be filtered because it usually carries considerable organic matter and turbidity.

The Milwaukee records show an appreciable reduction in the typhoid rate after chlorination was practiced regularly. Hypochlorite was used June 21 to Dec. 12, 1910, not at all during 1911, Feb. 2 to March 18, 1912, and then continuously after April 12, 1912, until May, 1915, when liquid chlorine was substituted for hypochlorite, and this has been used continuously since that time. The average for the five year period while



CURVE SHOWING EFFECT OF DISINFECTION OF CHICAGO PUBLIC WATER SUPPLY ON TYPHOID FEVER DEATH RATE.

disinfection was not in use, 1906, 1907, 1908, 1909 and 1911, was 21.8. For the period 1913-1917 inclusive, the rate dropped to an average of 8.9, or a reduction of 59%.

The water supply of Omaha is obtained from the Missouri river, which name is almost synonymous with "mud" and is coagulated and settled in large basins. In 1910 hypochlorite treatment was installed. For the period 1906-1909 inclusive, the typhoid fever rate was 99 per 100,000. For the period 1911-1917 inclusive, the rate was 25.4, a reduction of 74.3%, which is truly a remarkable accomplishment. The change to liquid chlorine was made in 1915. The death rate has steadily and consistently dropped since 1910 and for both 1916 and 1917 was below 5 per 100,000.

There is no doubt but that the use of liquid chlorine will continue to grow. The only danger is from over-zealous sanitarians recommending its application in cases where it is not called for or in cases where it should be used in conjunction with some other process. As with all purifying agents, it has its limitations. Within its sphere of usage, it has demonstrated its reliability and simplicity and its efficiency is proven by typhoid fever statistics.

FROM WORKERS IN FIELD AND OFFICE

Anonymous Communications

For many years newspapers have carried at their mastheads statements that they pay no attention to anonymous communications. Despite this practice, unsigned letters are occasionally received, intended for publication. Thus a letter was received by the editor, signed, "Disinterested Party and Not a Contractor." That nom de plume would serve well enough, but the identity of the writer should be made known to the editor. There is no objection to the use of an assumed name for publication, but the correspondent's real name should be confided to the editor. If an editor publishes a purely anonymous letter, he must assume the responsibility for it, and must either defend it or make a public disavowal of its import. Editors are busy most of the time defending their own actions, and cannot undertake to assume the responsibility for literary children whose parents disown their offspring.

Using Compressed Air Equipment on Street Repairs

Editor MUNICIPAL ENGINEERING:

Sir—We are using the Domestic compressed air equipment for street repairs. It requires but one man to operate this machine and the results have always been satisfactory in every way.

We can clean six brick with this machine to one by hand. When cleaning by hand many of the brick break, while with the machine we seldom ever have any breakage.

We have also used this equipment out in the field for riveting boilers, etc., and have found it very convenient, in fact, would not be without it.

Very truly yours,

THE ENTERPRISE PAVING & CONSTRUCTION CO.,

Cleveland, Ohio. James H. Rose, Pres.

The Cost of Drilling Blast Holes

Editor MUNICIPAL ENGINEERING:

Sir—The cost of drilling blast holes depends altogether upon the kind of rock, wages paid, the kind of machine used, the energy of the driller, the carelessness of the driller in keeping his machine in repair and making large repair bills when unnecessary, and a thousand and one other things which enter into the subject.

In some places it is with the greatest difficulty that more than 3 or 4 ft. can be drilled in a day of 10 hours, and in other places a good driller can drill more than 100 ft. per day of 5⅝-in. diameter holes. The kind of fuel used also enters into the subject, also the cost of same.

We doubt if any two quarries can show the same detail of costs. Some quarries have been obliged to suspend operations because of the enormous cost and the difficulty of sinking the blast holes.

Very truly

THE LOOMIS MACHINE CO.,

Tiffin, Ohio. Geo. D. Loomis, Pres.

Ohio Highway Department Employs Compressed Air Equipment in Repair of Brick and Concrete Roads

Editor MUNICIPAL ENGINEERING:

Sir—The compressed-air equipment which we used in the repair of brick and concrete roads was a Schramm (Philadelphia) outfit. The outfit consists of the compressed-air equipment operated by a small gasoline engine. This operates very much on the principle of a compressed rivet outfit and substitutes a chisel for the hammer. We carry twelve to eighteen chisels of different designs, in order to be able to select a chisel which is suitable for the specific class of work the outfit is doing. The outfit is used in trimming up the edges of an area to be patched or rebuilt in brick (cement filler) and concrete roads. The outfit works very satisfactorily in cutting vertical edges, and also, in the case of brick roads, in toothing out the edge in order to secure a suitable bond of the new brick patch with the old surface.

We cannot give any figures showing the exact results between the cost of work done this way and work done by hand, but we are quite positive that the work done by the outfit is accomplished much cheaper than it could be accomplished by hand methods; in fact, it would be almost impossible to accomplish the same grade of work by hand methods as by the use of this outfit.

Very truly yours,

CLINTON COWEN,

Columbus, Ohio. State Highway Commissioner.

The Bankhead National Highway

Editor MUNICIPAL ENGINEERING:

Sir—*The Literary Digest* of May 4 contains an article from MUNICIPAL ENGINEERING headed, "Speed Up the Roads!" I wish to commend said article as wise and most opportune. The delay of the state highway commissions in not responding to the request of Secretaries McAdoo and Houston is regrettable. The people of this country have not fully realized the full importance and necessity for good roads. The time will come, if this war continues, when good roads will be as essential in winning the war as the sale of Liberty Bonds today.

Here is proof of the great interest and enthusiasm displayed by the people of the South in road building. Eighteen months ago a small party of road enthusiasts met in Birmingham, Ala., with a view of linking together the roads between Atlanta, Ga., and Memphis, Tenn. At this meeting an organization was formed and the name adopted was the Bankhead National Highway Association. Pathfinders were appointed, who made a careful survey of the different roads and reported their findings to the board of directors. The demand from the people from Atlanta to Washington to be admitted into the organization was so great that a pathfinders' committee was appointed to make the survey. The road has practically been located east to Washington.

The western end of the road towards the Pacific ocean is being taken care of, as was shown by the large number of delegates, 1,780, that were present at the annual meeting of the organization held at Little Rock, Ark., on the 18th and 19th of April. Pathfinders will be appointed at once to make an examination of the road from Memphis to El Paso. This great transcontinental road will traverse the loveliest country in the world; can be traveled every day in the year, without regard to any special season. In some of the country through which it passes in the South the roads are never covered with ice and snow, but are bordered with green vegetation and beautiful flowers throughout the entire year.

This road will pass 17 cantonments. It runs from ocean to ocean, paralleling the great Lincoln Highway across the entire country. It is our hope to have the government take over these two lines of road as military and post roads.

Some of the results of the good road spirit along this route are already shown. Every stream from Memphis to Washington through which the road passes has been bridged, and some of them by individuals, at great cost. Two instances came under my personal observation where the grade of the road was above 20 per cent., and by great engineering these stretches have been reduced to 5 per cent.

Millions of dollars have been raised by the sale of county bonds throughout the entire length of this route, and land values have been increased largely by its proposed construction. So we have formulated a working plan, if the government will assist in its execution.

Very truly yours,

T. S. PLOWMAN, President,

Talladega, Ala. Bankhead National Highway Assn., Inc.

Making Tight Joints in Vitrified Clay Sewer Lines

Editor MUNICIPAL ENGINEERING:

Sir—Better joints for vitrified clay pipe are now being made by pouring the joint material than is possible by the old hand-troweling method. Proof of this fact, together with the development of more satisfactory equipment for the pouring method, makes it advisable that all vitrified pipe lines, where tightness is requisite, should be installed with poured joints.

The permanence of vitrified clay pipe, due to its resistance to chemical and electrolytic attack, coupled with its high tensile strength, has inspired a vast amount of search for joining methods that would be worthy of the pipe. The answer is the poured joint.

Joint Materials

Either cement grout or bituminous joint materials may be used with entire satisfaction for the construction of poured joints. The choice must depend upon conditions. The bituminous materials (such as G. K. compound, made by the Atlas Company, or Filtite, made by the Pacific Flush Tank Company) provide a quick setting joint that permits backfilling within a few minutes after the material is applied, while cement takes 24 hours or more to set. The bituminous joint has a certain amount of elasticity and is better for that reason wherever pipe is laid over refilled earth or wherever the pipe line is subjected to strains that tend to break it.

Poured vs. Troweled Joints

In comparing the two forms of cement joint, the poured and the troweled, the former will be found to have the following advantages:

1. Greater certainty of filling the pipe bell with joint material. 2. A denser cement when set. 3. More rapid operation. 4. Saving in joint material. 5. Less need for working space in trench. 6. A neater and more workmanlike job. 7. A cleaner operation from the workman's standpoint. Of these advantages, Nos. 1 and 2 relate to the efficiency of the joint and Nos. 3, 4 and 5 to its economy. Nos. 6 and 7 may be regarded as sentimental advantages, but they are not so. Vitrified pipe installations have suffered in the past from inexpert efforts of laborers and helpers, who were assigned to the task partly because it was dirty work.

The Form or Runner

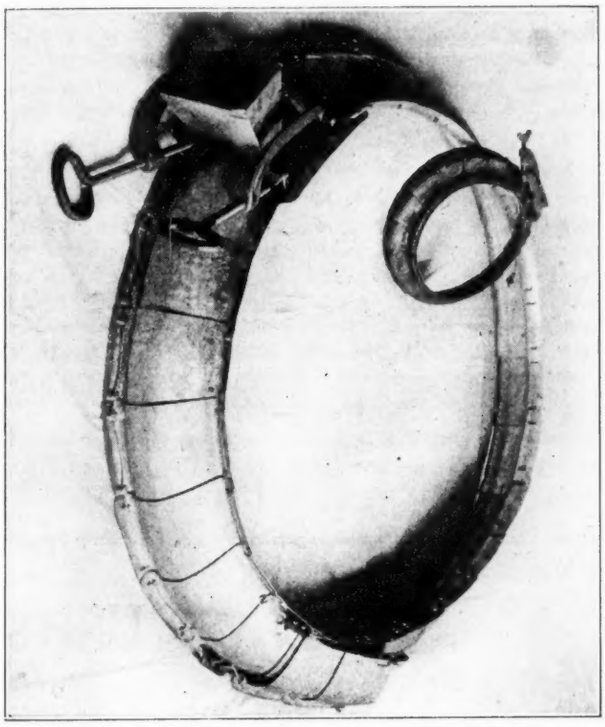
Pouring of joints necessitates a form to retain the fluid joint material. For pouring bituminous materials, heated to fluidity, it has been customary to use the familiar asbestos runner, sometimes called a "snake runner."

It has the shape of a section of asbestos rope, and is coupled around the spigot end of one pipe and pressed tightly against the bell of the pipe to be connected with it, after the bell has been caulked sufficiently to prevent the compound from entering the interior of the pipe line. Before pouring the heated compound, it is usually necessary to make a clay dam or funnel from excavated earth, surrounding the upper point of the joint where the compound is poured. The runner retains the compound in the bell. It may be removed in a few minutes, when the material has hardened.

The latest device for retaining fluid joint materials is the Flex-Form mold here illustrated, invented by the writer and manufactured by the Wyatt Engineering Company, of Columbus, Ohio.

The Flex-Form

The Flex-Form consists of a series of overlapping sheet



VIEWS OF 24-IN. ADJUSTABLE AND 6-IN. FLEX-FORM MOLDS FOR POURED JOINTS IN CLAY PIPE SEWERS.

metal plates or "scales" strung on two steel cables of small diameter and provided with a clamp and a funnel. The clamp is so adjusted that three different sizes of Flex-Form are a sufficient equipment for all of the different sizes of vitrified pipe from 3 in. to 24 in. The funnel divides in two parts when the forms are uncoupled for removal.

When clamped in position for use the Flex-Form holds the spigot end of one pipe centered in the bell of the pipe next to it and retains the grout that is poured in the funnel. During the period of setting it protects the bond of cement against any moderate shock or strain.

Making Grout Joints

The process of making grout joints with the Flex-Form mold may be briefly described as follows:

Mix equal parts of Portland cement and clean, sharp sand in their dry state. After thorough mixing, add water to produce a consistency of thick cream. Satisfactory grout cannot be secured if water is added before the dry ingredients are thoroughly mixed. One per cent. of water-proofing compound adds a factor of safety, but is usually not regarded as necessary.

After due precautions with regard to bedding and alignment of the pipe, insert spigot in bell as far as it will go and caulk lightly with oakum that has been dipped in the grout. Use just enough oakum to prevent the joint material from entering the interior of the line. More than this may weaken the joint.

Dip the Flex-Form in oil to prevent adherence of grout. Before applying, make certain that there is enough space beneath the bell in the trench to permit free passage of the Flex-

Form under and around the bell. Clamp the Flex-Form in place and make certain of an even grip all around the bell.

Pour a little water into the funnel to promote free flow of grout. Then stir and pour grout until funnel is full. There will be a slight leakage between the leaves of the Flex-Form, which is a safeguard against air pockets or accumulation of water.

Removing Forms—Testing

Forms should not be removed for 24 hours, when the trench may be backfilled, unless it is desired to test the line, as required generally by sanitary codes. In the latter case, the setting period should be 48 hours, after which the joint should be impervious under any prescribed water or smoke test.

Use of Compounds with Flex-Form

The Flex-Form mold is also well adapted to bituminous joints. It has two advantages over the asbestos runner, a dependable funnel and a shape which insures a bevel of joint material outside the bell. In cold weather, bituminous compounds sometimes chill in the bell of the pipe and fail to fill it. The greater volume of material used in the Flex-Form tends to maintain temperature and fluidity until penetration is complete.

Contrast of Methods

In contrast with the foregoing methods, the hand-troweled joint depends for tightness upon the care with which cement is rammed into every portion of the bell. In a cramped position in dark trenches liability to faulty workmanship is great. There is further liability on the part of the troweled joint material to run or sag during setting. Even where troweled joints are constructed with greatest care it is almost a certainty that the cement will be disturbed by manipulation of the pipe in making the next joint.

In the poured joint, gravity insures penetration of the joint material to the farthest recesses of the bell. The Flex-Form safeguards against running or sagging. Disturbance is avoided by placing all the Flex-Forms for the job (or day's work) before pouring the first one. They are then poured in succession and left to set.

Further, it is proven that a comparatively thin grout makes a denser joint substance, when set, than the relatively stiff mortar used in the troweling process.

Joints in Vertical Pipe

In vertical pipe lines the bell end of the pipe is placed uppermost, the spigot of the next pipe inserted and caulked and the joint material poured into the bell, which retains it during setting, without the aid of a runner.

In joining horizontal lines of small diameter pipe with a bituminous compound, it is common to join the pipe in couples or threes by this method and leave them standing upright until the material is cold. The two or three sections are then treated as single sections of longer pipe and joined to each other in the trench with the aid of a Flex-Form or asbestos runner.

Very truly yours,

1672 Summit St., Columbus, O. DEWITT H. WYATT.

PLANT UNITS AND LAY OUTS

New Concrete Mixer Loader a Big Cost Cutter

The Koehring mixer loader is adapted for use either with the end loading paving mixers or with the side loading mixers used on general construction work. It increases mixer production and reduces to the minimum the owner's dependence on manual labor. It eliminates wheelbarrows entirely.

It can be used with any mixer without changes in the mixer except the placing of a baffle plate in open end loading skips, which is a simple job for any local mechanic. No baffle plate is required with closed end loading skip.

In paving work it precedes the mixer under its own power. In use with side-loading construction mixers it bridges the gap between materials and the mixer; thus the materials may be unloaded at the curb side, shoveled into the measuring bins of the loader and conveyed by the moving belt to the mixer at the base of an elevating tower, at the side, or on the inside of the building.

The use of the Koehring loader in the operation of a two-bag paving machine on street work shows the possible payroll saving. The loading crew usually consists of four wheelers for stone and two for sand—in other words, six wheelers per batch—and two sets of wheelers and one set additional shovelers are usually required to keep the mixer operating at top capacity. This means in all eighteen men. If, with the mixer loader, six men are retained for shoveling materials from subgrade into measuring bins of the loader, a total of twelve men or all the wheelers have been eliminated.

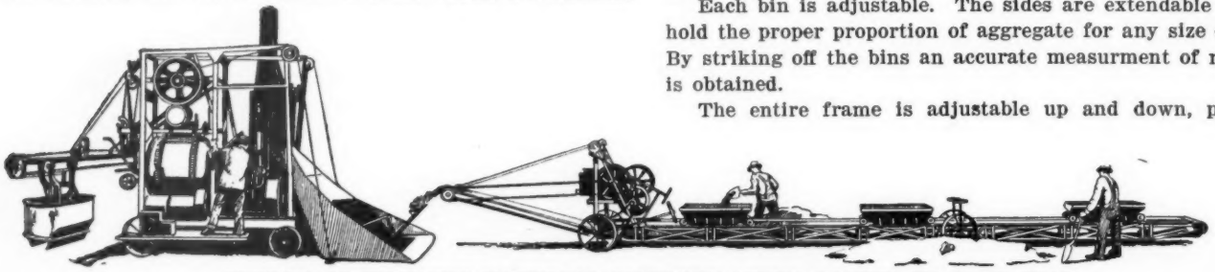
The mixer loader is a combination of measuring bins and the belt conveyor principle applied to a light portable machine, which is supplied with its own power and traction, moving from job to job under its own power and in paving work preceding the mixer. The full over-all length of the machine is approximately 60 ft. It receives materials from any point within this distance of the mixer. For shipping, half of the frame is quickly detachable.

The measuring bins are mounted on the frame and provided with wheels which roll on tracks on the top and along the length of the frame. According to the capacity of the mixer, two or three bins are provided.

As materials are shoveled from the subgrade, as in paving work, these bins are moved along the top of the frame to maintain them in convenient shoveling position to materials.

Each bin is adjustable. The sides are extendable so as to hold the proper proportion of aggregate for any size of batch. By striking off the bins an accurate measurment of materials is obtained.

The entire frame is adjustable up and down, providing



SKETCH OF THE NEW KOEHRING CONCRETE MIXER LOADER IN OPERATION.

plenty of clearance for traveling from job to job, and permitting the structure to be lowered to a point of small "lifts" in shoveling materials from the subgrade. The range of this adjustability is 10 in.

When bins are filled with aggregate, properly measured, a lever control opens the bottom of each bin, permitting aggregate to fall on the conveyor belt, moving at the speed of 500 ft. per minute, which carries materials to the mixer and into the loading skip, which is then operated in the usual way.

The speed of the conveyor belt necessitates the use either of the loading skip or a measuring batch hopper, because the high speed of the belt conveyor does not permit the new charge to be started toward the drum until the last batch has been completely discharged. This would cause a delay on each batch, and a delay on the part of the bin loaders. The mixer loading skip or batch hopper, however, is always ready to receive the aggregate from the belt conveyor, and the shovelers can instantly reload the measuring bins of the loader. In the meanwhile when the last batch has been two-thirds discharged from the drum, the loading skip has been started as is the usual practice, so that new aggregate enters the drum at the instant the last preceding batch is discharged.

Some Hints on Economical and Ornamental Street Lighting

By F. M. Jourdan, South Bend, Ind.

Conservation is a word heard repeatedly and it is well to consider some phases of its meaning. First, it is to take care of what we have, that its usefulness may be prolonged. Next, it is to be sure our methods bring the maximum results with the minimum expenditure of time, money, and labor. From the latter angle conservation may call for considerable outlay to supplant obsolete and inefficient apparatus with that which is modern and efficient, nevertheless, if by so doing, better results are obtained for less cost, not only is it good business practice, but it is conservation in the best sense of the term.

Inefficient Arc Lamps

One fertile field in which this sort of conservation can profitably be employed is street lighting. Many places still use various types of arc lamps with their flickering light, which require constant attention and are increasingly expensive to maintain. To replace these lamps with pendant fixtures, using the highly efficient Mazda "C" lamps, institutes a saving which in some cases, is sufficient to pay for the cost of the change in less than a year. This means a smaller appropriation for maintenance for the years following, or permits an increase in the number of lighting units without adding to the sum formerly assigned to the arc lamps.

Advantages of Pendant Fixtures

Incandescent lamps being available in different candlepower sizes, it is possible to select a lamp that will give just the right amount of light and keep power consumption to a minimum. Pendants should be selected that have a provision for adjusting the position of the lamp socket, so that no matter what size of lamp is used, it can be placed at the proper point with respect to the reflector and diffusing globe. Pendants, if made of cast iron, galvanized and coated with an enamel paint, cannot be dented or forced out of shape in shipment or handling and the protective coatings prevent corrosion, so that if the paint is renewed occasionally they will last indefinitely. When used on series circuits, Mazda lamps should be held in cutout sockets so that when a lamp fails for any reason, the cutout will puncture and maintain the circuit, otherwise all lamps will remain out and difficulty will be experienced in locating the seat of trouble. The design of the socket should be such that only the proper film can be used, thus assuring the certain functioning of the cutout.

The Ornamental Post

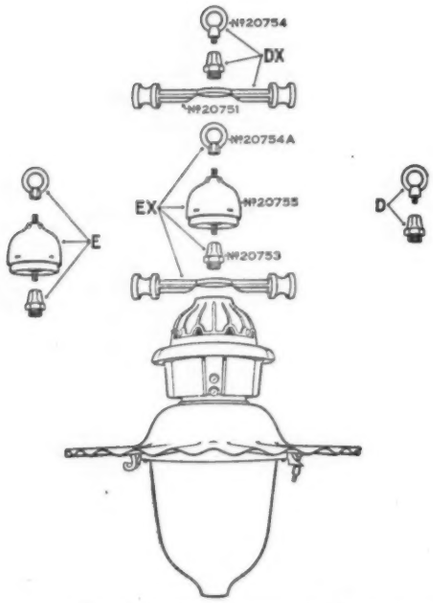
One of the most modern methods of utilizing the advantages of Mazda lamps is the ornamental cast iron post, surmounted by artistic diffusing globes which are attractive by day as well as by night, combined with efficiency of illumination. Adequate lighting is a good advertisement for the community which supplies it; and post lighting combines both in one. The ornamental post with its cluster of lights, served its purpose in the days before the large gas-filled lamps were introduced, but at the present stage of the art, clusters are considered wasteful. The several small lamps are not as economical as one large lamp, either in wattage or maintenance of glassware. Considered from an illuminating standpoint, the cluster does not meet the standards set by the best engineering practice. In most cases it is possible to remove the cluster top from an ornamental post and replace it with a single unit fixture, thereby bringing the unit up-to-date at a small cost, in many instances the cost of the change will be saved in less than a year.

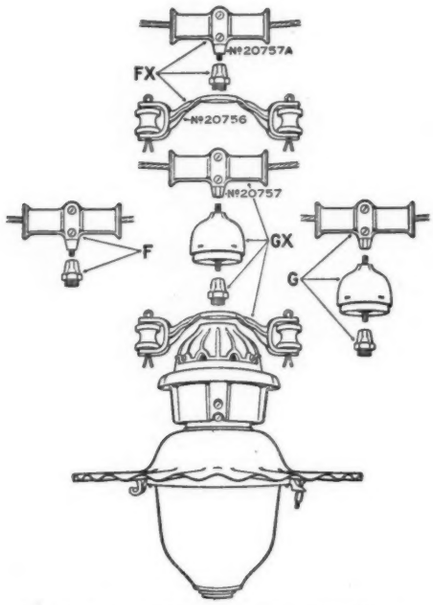
TYPES OF MODERN AND OBSOLETE STREET POST LIGHTS.

Left to Right: One-Light Broadway Post, a Modern Unit; Broadway Post With Cluster Top, Obsolete Type; One-Light Arcadia Post, Combining Simplicity and Efficiency.

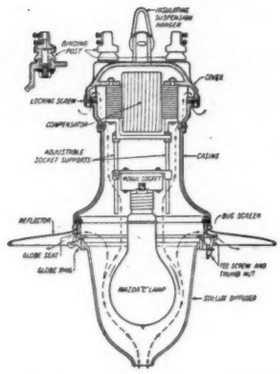
Lighting New Industrial Streets

The springing up of new plants to engage in the manufacture of war material, has in many instances necessitated the laying out of streets in their vicinity and the building of many houses to accommodate the employees. These new areas require lighting as much as do the older thoroughfares. Such cases usually call for a street lighting system that is flexible and easily installed. The Streethood is a fixture that fulfills the requirements for this work. Built up from interchangeable





INTERCHANGEABLE PARTS FOR EIGHT STYLES OF CUTTER STREETHOODS.



SECTIONAL VIEW OF CHICAGO TYPE PENDANT.

parts, it can be adapted for mounting on a bracket; hung from a mast arm; or suspended from a span wire. Fitted with either a multiple or a series socket and provided with a correctly designed porcelain enameled reflector, and either a diffusing globe or a refractor, most any condition influenced by spacing distances, mounting heights, circuit or intensity of illumination can be met. In parks and other seasonable resorts, in fact wherever a durable, inexpensive and efficient outdoor lighting fixture is needed, the Streethood admirably adapts itself to the requirement.

With the foregoing forms of lighting units from which to choose, any community can have well lighted highways and public places, and at the same time conserve the nation's resources. In fact, wherever the present lighting methods or equipment are obsolete, a change to modern units will conserve coal and labor, and the decreased operating and maintenance expense will save the cost of the new installation in a short time.

CHICAGO TYPE PENDANT WITH THE "SOL-LUX" DIFFUSER.

CHICAGO TYPE PENDANT WITH SKIRTED REFRACTOR.

GENERAL ARTICLES

Some Observations on a Common Practice in Sidewalk Construction

By Winfred D. Gerber, Civil and Sanitary Engineer, 913 Chamber of Commerce Bldg., Chicago

I think every specification I ever read on the construction of cement or concrete sidewalks had a clause, of more or less length, devoted to the *idea* that the walk should be constructed as a series of detached blocks or flags, the intent being to have the blocks so constructed that when the walk was ready for service each flag would be a unit within itself and any disturbance it might sustain would not be communicated to the adjacent flags.

Unit Blocks

My earliest recollections of sidewalk construction are of contractors who produced just these results by so arranging the sequence of their work that a flag was not laid until the adjacent one had set and paper partitions had been placed between flags at the joint. The two common methods of procedure were: (1) To begin at the center and work alternately at either end, and (2) to lay each alternate flag throughout the length of the job and when these had set for 24 hours or longer to lay the intermediate flags, strips of tarred building paper being placed in the joint between flags as an extra precaution against sticking.

The contractor of today is continually on the outlook for methods and appliances for increasing the efficiency and output of his organization and which at the same time will permit a reduction in the cost of manual labor. This is a perfectly natural development and one which is not open to criticism unless the desire for output outweighs the desire to do good work. On the other hand, to the average purchaser, "all walks look alike," and he proclaims, "He won't be held up by any bunch of sidewalk contractors," and proceeds to let his contract at the lowest figure. Naturally, the contractor,

not being a philanthropist, resorts to "methods" of construction in order to make good on the price.

Common Faults in Construction

The list of "methods" used in making good on a cheap price are so numerous that space does not permit reciting them, but a few of the most common may be cited, i. e., insufficient compacting of the foundation, any old material for foundation or filling, undersized form lumber, etc. These all have a certain amount of influence on the durability of the finished walk, but the point I wish to make is one of the "methods" frequently observed, of making these so-called separate flags. This usually consists in first marking off on the side rails the lengths of the flags; a cross rail *may* or *may not* (it's about 50-50 either way) be placed as a physical limit of the flag. Such a cross rail, however, has but little to do with actually defining the length of the flag, for the reason that about as soon as the base course has been placed and tamped it is removed and a new flag started without further ado. The finish coat is applied without regard to the limits of the flag and when it is ready to be finished a straight edge is placed across the walk at the marks on the side rails and with this as a guide the *surface* is neatly marked off in definitely defined rectangles by the use of a cutter, which only cuts down a short way, leaving the lower portion of adjacent flags in intimate contact, and when the cement has set they are practically as one piece. One has only to observe the cracking of a cement walk at other locations than these so-called joints to be convinced that it is not the weakest place in the walk. I recall a small city in Illinois, where the only limit the contractor had in laying a single length of walk was the length of the block. The surface was marked off to look like blocks, but as a matter of fact the walks were continuous for a block in length.

Again, I have never felt that a comparatively thin wet top coat laid on a rather dry base course was a desirable way to get a good walk. All too frequently the top checks off and leaves a poor looking, as well as rough-surfaced, walk, particularly if the walk is being laid during cool or frosty weather.

Suggested Improvements

Much improvement has been made in the construction of concrete pavements. Why not use some of this experience on sidewalk construction and make the entire thickness somewhat thicker than is now the practice, of one consistency and mixture, flushing enough mortar to the surface by proper compacting so that the required finish may be given to the surface. Make the slabs in lengths of approximately 20 ft. with a definite expansion joint ½ in. wide, filled with some type of asphaltic joint filler between each adjacent section. A mark or groove across the walk every 5 or 6 ft. adds nothing to the usefulness or durability of the walk unless it efficiently fulfills the function for which it was made; otherwise it is "camouflage."

Observation of walks that are kept well cleaned during the winter show indications of greater frost effect (heaving) than walks covered with snow all winter long, as the clean walk gave opportunity for the cold to penetrate more quickly the walk and freeze the damp foundation. Improvement in this particular may be obtained by lowering the level of ground saturation by installing a system of tile drainage and by placing a firm but porous foundation under the walk of sufficient thickness to prevent the formation of ice adjacent to the under side of the slab.

City Planning as an Engineering Problem

By Nelson P. Lewis, Chief Engineer, Board of Estimate and Apportionment, Municipal Building, City of New York

The subject of city planning has lately attracted much attention on the part of municipal officers and groups of public-spirited citizens, while it has been the subject of study and discussion by many whose interest appears to have been largely academic. Many of the writers upon city planning have been architects, landscape architects, students of municipal affairs and civic workers, and in not a few cases the authors appear to be somewhat superficial observers whose attitude has been severely critical and who have seldom found anything to commend in their own country.

Shortcomings of Some European City Planning

Up to within the last three years, most of them were enthusiastic in their praise of German efficiency in the planning, as well as in the administration, of their cities, which were almost invariably held up as the last word in city planning. German efficiency in administration will be quite generally acknowledged, notwithstanding the fact that behind that efficiency we have lately seen a brutality rarely matched in the history of the world. In German planning, the chief emphasis appears to have been placed upon the impression to be produced upon the visitor. Dr. Werner Hegeman, of Berlin, has himself pointed out that in the remodeling of some of the European cities, only beauty and elegance were sought and that

> "to the production of this metropolitan elegance, the most refined thought was given, but this thought benefited mainly the central sections of these capitals (the parts near the castles) and the exterior facades of the tenement houses. Behind these good-looking facades, miserable crowding, lack of house gardens and the choking of the next generation were permitted. This kind of city planning did not attempt to make comprehensive, preconceived plans covering all branches of city growth, but touching only one or two aspects (mainly artistic), exaggerated their importance and did nearly as much harm as no planning at all."

Conditions Producing Tenement Houses

The same authority, in an equally frank criticism of the conditions existing in Berlin and Charlottenburg and an attempt to put his finger on the reason, has noted that this metropolitan district, with hundreds of thousands of families in one-room houses,

> "is suffering from too wide, too well paved and too highly organized roads, and from the extensive high tenement houses that seem necessarily to result from too expensive roads carried into purely dwelling house districts."

Correcting Mistakes Due to Lack of Plan

The American literature on this subject abounds in illustrations of foreign cities with views showing the grouping of public buildings and picturesque "plazas," many of which there has been a disposition to transplant to this country, however inappropriate they may be to the topography and to the traditions of the people. Too little attention has been given to the structural plan of the city, and yet it is this very structural plan which may make a city convenient, orderly, and even beautiful, and which will avoid the necessity of extensive changes at immense cost. Such changes, involving sometimes complete reconstruction of certain districts, have been undertaken by American and foreign cities, and they have probably been well worth while. These projects are commonly called city planning, but they actually amount to little more than the correction of mistakes, due to lack of a proper plan.

An Engineer's Definition of City Planning

City planning has been variously defined by those who are disposed to emphasize its architectural, its social or its economic aspects. The writer's definition, frequently used by him, is this:

> "City planning is simply the exercise of such foresight as will promote the orderly and sightly development of a city and its environs along rational lines, with due regard for health, amenity and convenience and for its commercial and industrial advancement."

This definition may be recognized as that of the engineer, rather than of the artist, the economist or the social worker, and yet, while it lays stress upon the practical aspects of the problem, it does not ignore the ideal.

If it be admitted that the need of planning is fundamental and that the plan should exist from the beginning and should direct and control the growth and development of the city, it must be admitted that the engineer must play a very prominent part in the development of the plan, and it must also be frankly admitted that the failure on the part of the engineer, who is almost invariably the first man on the ground, to realize the importance of the preliminary work done by him and its controlling influence upon the future of the city, has been the excuse for, if not the contributing cause of, the expenditure of vast sums for reconstruction or for the correction of mistakes.

Conspicuous Elements of Proper Plan

Bearing in mind, then, the definition of city planning which has been given, the conspicuous elements of a proper plan will be briefly outlined, and first among these elements the writer will place the unromantic but vitally important matter of the transportation system, or the means provided for getting in and out of the city and for the quick movement of passengers and freight from one part of the town to another. It is obvious that transit needs cannot be accurately foreseen, but provision should be made for improving them and extending them when needed. A large part of the transportation will always be in the streets themselves, and its adequacy and efficiency will be largely determined by the location and dimensions of the streets in which the interurban transit lines are located.

Street System

This brings us to the second important element, namely, the street system in which and through which the daily business is done, and by which the people gain access to their homes and pass from these homes to their work, their recreation and their amusement. The street system, once adopted and developed, must remain indefinitely. Some streets may be widened and an occasional new street may be cut through existing improvements, but the general street plan, once established and constructed, is fastened upon the city as long as the city itself lasts. It occasionally happens that a catastrophe, such as the great fire of London in 1866, or the San Francisco earthquake and fire in 1906, may afford an opportunity for recasting the plan of a considerable area, but in the feverish desire to make a new start and lose as little time as possible, such opportunities are rarely embraced.

Open Spaces

But a city is not merely a place in which business is conducted and in which the inhabitants work, eat and sleep. Provision must be made for recreation and wholesome amusement; public health must also be promoted by the introduction of sufficient open spaces, which actually serve as the lungs of the city. Parks and playgrounds are essential to the well being of an urban population, and no city plan will be complete which does not make provision for them. It is true that a lack of public parks may be supplied at any time, even when the space to be devoted to that purpose shall have been built upon, and when the cost of their acquisition will be greatly enhanced, but a park system can be most economically and satisfactorily established in advance of other improvements and facility of access to it and proper connections between the different park units will depend upon the street system, so that it is desirable that park plan be worked out in connection with the street plan.

Public Buildings

It must be remembered also that a city is a corporation conducting extensive business enterprises and suitable buildings must be provided for the purpose. The location of such buildings may render the conduct of public business convenient or difficult, and may give a favorable or unfavorable impression to visitors. Public buildings, like other business buildings, can be changed in location as necessity and convenience require, but the suitability of their sites, whether they are convenient and commanding, or awkward and unprepossessive, will depend upon the streets about them and leading to them, so that the location of these streets should receive most careful study in the preparation of the general plan of the city.

Sane Financing

But good city planning, even in its engineering aspects, involves more than the elements just enumerated. It includes plans for the sane financing of various public improvements in order that the burden of cost shall be distributed as equitably as possible, that the few are not enriched at the expense of the many, and that the city's credit shall not be recklessly used. It includes a study of the traffic problems of the town, not only provision for traffic in the working out of the street plan, but its regulation, in order that the existing street facilities may be used to their fullest capacity, avoiding in many cases costly changes which may be deemed necessary to accommodate unregulated traffic when, by the introduction of better system and control, the desired results can be secured by ordinance, instead of by bond issues or assessments.

Development of Private Property

The framework of a city may be intelligently planned, and yet the objects sought may fail of realization owing to the lack of such control over the development of private property as will insure health, amenity and convenience. Healthy living may be rendered impossible by over-intensive development, failure to provide sufficient light and air through the absence of adequate courts and back yards, and the lack of restrictions as to the height to which buildings may be erected. Amenity, or pleasantness of surroundings, requires good design of the streets and their details—not the introduction of fountains and statues and other highly decorative features, but good proportion and the obvious adaptability of means to ends, the repression of garish and obtrusive signs and hideous noises. The convenience and comfort of those using the streets are sacrificed if private owners are permitted to encumber the sidewalks by projecting portions of buildings or by temporary occupation for the display of goods, while street capacity, which might be ample if the abutting buildings were of moderate height, may be seriously congested if buildings are allowed to be carried to any height which the owners may find profitable.

The Environs of the City

Careful study may be given to and skill shown in the orderly planning of portions of a city, or even of the entire area within the city limits, and yet, when the boundary line between the city and the adjacent towns is passed, the roads may be of inadequate capacity or without proper articulation; the approaches to the city may be shabby and uninteresting and the only available roads leading to the neighboring towns may be tortuous in their course and may pass through the meanest parts of both, giving the traveler a very unfavorable impression. The environs of the city should, therefore, be studied in connection with and in relation to the plan of the city itself.

Semi-Public Buildings

While the original ground plan has chiefly to do with the street system, the provision of suitable sites for public and semi-public buildings should be kept in mind. While the precise location of such buildings cannot be designated far in advance, the general plan should be such that a special site need not be created for each building as the time comes for its erection, streets being widened and new streets cut through in order to provide access to it or to enable it to be seen to advantage. If, for the sake of public convenience and

in order to secure a good architectural effect, the important public buildings can be so grouped as to create a civic center, it should not be necessary to recast the street plan in order to do so. Not only for the buildings which are erected by the city and used for its public business should suitable sites be provided, but those of a semi-public character, such as railway stations, private educational institutions, churches, places of amusement and others, will, if properly designed and advantageously located, add character and distinction to the city and are entitled to consideration in the preparation of the original plan.

Prudent Land Policy

Certain parts of the city will be peculiarly adapted to specific uses, depending upon the topography, accessibility to transportation lines and other considerations. There will be business districts, industrial districts, high-class residential districts, and those where workmen can find cheap homes or low rents convenient to the places where they are to be employed. Special developments on the lines of the so-called garden cities, either for the accommodation of those employed in the business districts or in connection with industrial plants, will be undertaken if there are places available for them, and, in order that this may be possible without going miles beyond the city's limits, considerable areas can well be left undivided in order that such developers may have a rather free hand in carrying out such plans, provided always that there is a competent authority with full power to control the general plan and whose approval should be required before it can be carried out. American cities generally have little power of initiative. Legislative action is commonly required to permit them to do constructive work themselves or to enable them properly to control improvements undertaken by private individuals or corporations. Laws permitting them to do, to allow others to do, or to forbid others from doing, seem therefore to be necessary, and the framing of wise laws to this end is an important part of a city planning program. European cities are often large landowners and frequently indulge in land speculation, from the profits of which many of their social activities are financed. The adoption of and consistent adherence to a wise and prudent land policy is therefore necessary. Frequent changes of administration and reversal of policies have made state legislative bodies reluctant to give much power of self-government to American cities and public opinion appears to incline to this view. Intelligent city planning and the orderly execution of a plan depend to so large a degree upon municipal prudence and self-restraint and upon continuity of policy and purpose that municipal officers will have to show that they are capable of exercising such restraint and of working out and adhering to wise and prudent, even though they may be progressive, policies before they will be given that degree of self-government, the need of which is so obvious at the present time.

Did space permit, more emphasis might be placed upon the four primary elements of city planning, which have been pointed out as fundamentals. The importance of the first preliminary surveys should be insisted upon, which surveys will aid in the determination of the best location for trunk line railroads and terminals, so that they may be properly coordinated; a determination of the lines of main drainage, the best routes for arterial highways, the location of unimproved tracts peculiarly suited to park purposes, etc.

In connection with the street system, it should be pointed out that there should be a definite paving plan, as well as a street plan, the pavement in each case being selected with due regard for the grades, the amount and character of the traffic and the actual or probable use of the abutting property, keeping in mind also the need of continuous low-grade routes, with non-slippery pavement, by which all parts of the city may be reached under the most adverse weather conditions.

The Engineer's Responsibility and Opportunity

Attention should also be called to city management as an attractive field of activity for the municipal engineer. In this capacity, the handicaps due to defects in the city plan will be brought home to him very forcefully, and he will appreciate more fully the defects of a plan which are due in no small degree to lack of imagination and foresight on the part of the engineers who laid the foundations upon which the city has been built. The engineer does not yet appear to appreciate fully his responsibility for starting our cities in the right way. An engineer of one of the cities of Belgium has said:

> "Engineers appear to take little interest in the subject, and if their apparent indifference continues much longer, they will find that this natural branch of their profession will pass into other hands, which would be much to be regretted."

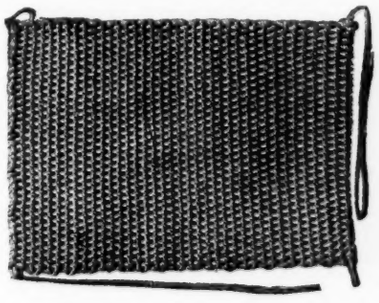
There are others ready and anxious to do this work, and if the engineer allows his natural title to the job to go by default, he will have no one to blame but himself.

Methods Employed and Precautions Observed in Blasting in City Streets

L. B. Steele, of E. I. du Pont de Nemours & Co., Wilmington, Del.

Blasting in city streets has been a problem to contractors and municipal engineers in the past due to the fact that, although all recognized the tremendous power of blasting powder as a time-saver, yet the possibility of accident prevented many from making use of explosives in sewer or subway excavation, except at rare intervals.

The war with its demand on the man power of the nation has cut down the supply of labor on which contractors have depended for the work in city street excavating and as a result of this shortage of available men, many engineers and contractors are at this time considering the use of blasting powder



BLASTING MAT USED IN BLASTING IN CITY STREETS.

in this type of excavation. They are studying the characteristics of this giant laborer with a view to adapting it to their needs.

The Two Essentials

The two essentials to be kept paramount in the use of explosives in city street work are: Care in handling and use of proper amount of blasting powder. If the contractor or engineer wishes to obtain the best results from the blasting method, he must have an intimate knowledge of these essentials before proceeding with the work. A failure to do so may result in the loss of life, damage to adjacent property and failure to accomplish the desired result.

The care used in handling the blasting powder should never be lessened from the time the explosive is bought until the blast has been made. The workmen must be informed that they must take the necessary precautions to insure safety and the foreman on the job must see that these safety instructions are followed explicitly. Some of the chief requirements are:

Chief Requirements for Safety

The blasting powder should not be kept in a wet or damp place, but should be stored in a dry place, under lock and key.

The workmen moving the kegs of blasting powder should avoid rough handling and care should be exercised in regard to smoking in the vicinity of the stores of blasting powder.

Probably the greatest caution must be taken when the blast is fired as the possibility of a person being in the locality should be prevented. All residents on the street should be notified to stay indoors. The square in which the area to be blasted occurs should be guarded at both ends and all workmen should get behind some sheltering object just before the blast is fired.

The Approved Method

In order that the most desirable results should be obtained, blasters should use the prescribed methods for work in city streets. Wide experience in excavating has shown that the following method is most satisfactory. A dependable, uniform blasting powder should be used, such as the red cross grade, and small charges should be used at each blast. This prevents danger of particles of rock and dirt being thrown great distances and also eliminates the possibility of breaking windows in the vicinity due to the concussion.

It is a wise policy to make a series of shallow blasts rather than one deep blast as the results will be more desirable when the series is used. Another step in obtaining a successful street blast is the use of the electric firing method instead of fuses as this insures complete control of the time of explosion.

Use of Blasting Mat

Most municipal contractors, who are doing any blasting in streets, are, in addition to the following precautions, using a "blasting mat" over the bore hole. This is a closely woven mat of hemp or wire rope that is used to catch flying material. The mats are made from 1 to 1½-in. rope and in rectangular shape. If the blast is light, the mat may be spread on the ground over the bore holes. If a heavier charge is used, railroad ties or logs should be put down and the mat placed on top of them. A view of the blasting mat is shown herewith.

If the contractor uses the foregoing methods and takes the required preventive measures all kinds of trench and subway work can be done by blasting in quicker time, at less expense and as safely as when blasting powder is not used.

How Engineering Records of Underground Structures Are Kept in Baltimore

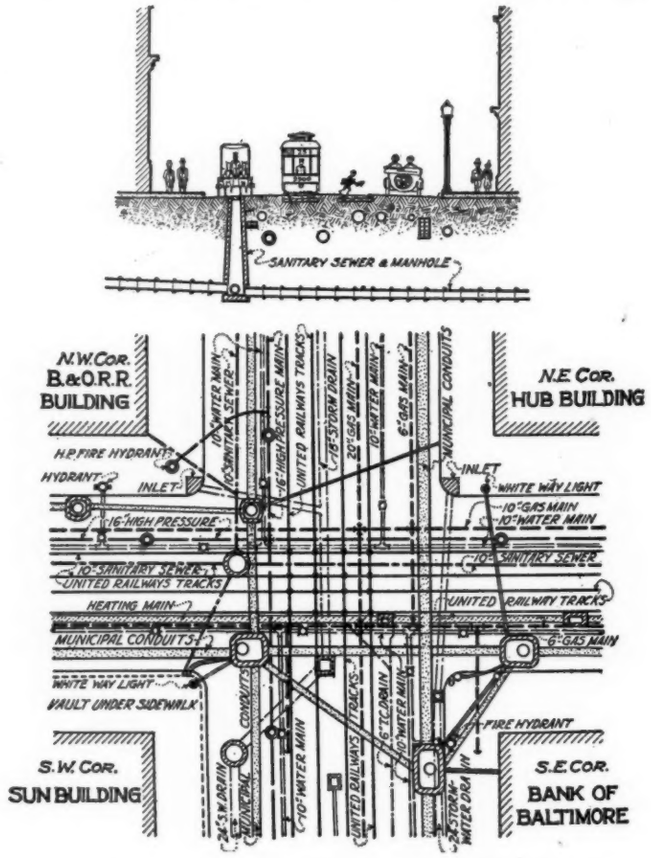
By M. J. Ruark, Chief of the Bureau of Drafting, Baltimore, Md.

The location of constructions which are above ground is comparatively simple. To keep an accurate record of underground instalations is quite another matter. Yet the city of Baltimore has in its possession, in plat form, with specific data as to location (depth and distance from the building line), a complete and up-to-date record of every live underground construction in the city, and of many obsolete private sewers and abandoned pipings. When the water department or the electrical commission sends out a force of men to do repair work they are not only furnished with complete data as to location of the particular construction they are to uncover, but are given the positions of all other installations which are to be found at that point, in order that they may not damage them during their operations.

The preparation and safekeeping of the innumerable plats which such a comprehensive system entails is in the hands of the bureau of drafting. Since the latter part of 1915 all the drafting forces of the city, with the exception of the building inspector's department, have been working as a separate and distinct department.

Water Department

The water department construction work is plotted in colors on mounted paper plats, about 28x28 in., to a scale of 1 in. equals 100 ft.; four of these sheets assembled together making a square of one mile. These plats show the reservoirs, pumping stations, main distribution pipes, services, valves, fire hydrants and other appurtenances, and are kept in a large case, the plats being hinged in a vertical position from which they can be moved or be replaced without difficulty. This method is very handy for quick reference. At this time we contemplate preparing record plans, on tracing cloth, on a scale of 1 in. equals 40 ft., about 24 ins. by 36 ins. in size. These plans will be traced from similar plats prepared in connection with the sewer work (described hereinafter) and will show, not only the size of all mains, services and appurtenances, but also the exact location, depth, etc., and it will then be possible to secure from these blue-prints, on paper or linen, which may be utilized by the construction forces either in the field or sub-offices. It is also expected that these plans will be used by the construction division in shutting



SECTION AND PLAN OF UNDERGROUND STRUCTURES AT THE INTERSECTION OF BALTIMORE AND CHARLES STREETS, BALTIMORE, MD.

down mains, both in case of failures and when new construction work makes it necessary to put out of service portions of the city's distribution system. In connection with these plans there will also be adopted a card system for keeping a complete record hereafter of each and every service installed. This scheme will shortly be put in final shape.

Electrical Commission

The city of Baltimore was the first city to establish a system of municipally owned and operated electrical conduits, to be leased to the telephone, telegraph and other public service corporations, on a duct rental basis. This improvement was started about eighteen years ago and is still in the course of extension. A very complete and detailed record of the construction has been kept since its beginning. Plans showing the work to be installed are now prepared on a scale of 1 in.

equals 40 ft. from which blue and white prints, for field use, are made. The engineering field force or inspectors record on these white prints any modifications or changes which may be ordered by the engineers in charge of construction, or which may become necessary owing to sub-surface constructions. These changes, as well as the actual measurements with complete details, are forwarded to the drafting room and are plotted on mounted paper plats about 26 by 36 ins., on the scale of 1 in. equals 20 ft. This drafting work is executed by draftsmen specially trained and skilled in such drafting and is the best record of this character, to my knowledge. Drawings of each cable manhole or box are also made to a scale of ½ in. equals 1 ft., for the cable inspection department, in order that a complete record may be available showing each electrical cable installed by public service corporations and which duct is occupied.

One of the first problems of the engineers engaged on the installation of the sanitary sewerage system was the preparation of a complete sectional map of the city to a scale of 1 in. equals 40 ft., showing the size, location and depth of all subsurface structures installed up until that time. These data were collected from numerous sources and some of them were therefore more or less unreliable.

A careful record was, of course, kept of all sewers, house connections and all drains installed and practically all of this work has been plotted and the records are available for ready use.

Construction notes and data in connection with this work were kept in surveyors' field books, as is the usual practice amongst engineers in general.

Gas Mains

The Gas Company (The Consolidated Gas, Electric Light and Power Company) keeps its own records and, by experience, this corporation has found it to their advantage and also economical in the long run, to take particular pains that a complete and careful record is kept of all their work. In fact they go into a good deal of detail and even locate each and every joint in the pipe lines in order that they may more readily locate leaks which later occur. They are thereby able to repair such leaks with the least amount of disturbance to the improved paving.

In order that the reader may obtain some idea of the costly and complicated system of underground mains and conduits and of the functions of the Bureau of Drafting in this connection, the accompanying illustrations have been prepared showing the intricate network of underground mains and conduits, at the intersection of Charles and Baltimore streets.

Prior to the activities of the Paving Commission it is the practice of all municipal departments to renew and rearrange these mains and conduits in a manner sufficient for future as well as present demands, but even with this forethought and caution it sometimes becomes necessary to tear up recently improved thoroughfares. For instance, water mains will freeze during severe weather, sewers and drains will become choked (usually through the carelessness of the property owner), and many other emergencies will arise which will necessitate the tearing up of new paving. To avoid this tunneling is quite often resorted to, it being a well-established fact that the pavement once cut into can be restored to its original condition only with difficulty, if at all. The average pedestrian is quite unaware that such repairs are being made under the street without any inconvenience to him or the closing of the street to ordinary vehicle or street railway traffic.

Not only does the keeping of these records save considerable expense in making repairs and installing additional structures when required, but a considerable saving of time is also accomplished and the inconvenience caused to the public materially lessened.

The intersection of Baltimore and Charles streets has been selected in this case as representing only the average conditions.

CATALOG REVIEWS

ONE-TON TRUCKS—Issued by Maxwell Motor Co., Inc., Detroit, Mich. 6x8 in.—16 pages. Illustrates Maxwell 1-ton trucks and explains field of their usefulness. Shows some major features of design and gives chassis specifications, body dimensions and price list.

SEWER INLETS—Issued by the Burch Plow Works Co., Crestline, Ohio. 6x9 in.—30 pages. Relates especially to the Burch Sewer Inlets, which are illustrated and described in detail. A large variety of designs shown. Catalog also features manhole covers, rooter plows, steel road plows, cast iron culvert pipe and bulkheads for pipe. Other Burch literature illustrates and describes the Burch stone spreader and distributor and the Burch stone unloader.

LAND DREDGES—Issued by the Bay City Dredge Works, Bay City, Mich. 6½x10¼ in.—30 pages. Shows Bay City land dredges in operation on a large number of interesting jobs. Contains many testimonial letters, giving operating data.

ROAD MAKING, ROCK CRUSHING AND EARTH HANDLING EQUIPMENT—General catalog No. 18, issued by the Austin-Western Road Machinery Co. 9x12 ins.; 48 pages. Illustrates, describes and shows the field of application of the lines of road making, rock crushing and earth handling equipment manufactured by this company. Especially features reversible road machines, graders, road rippers, the Austin Ripsnorter, Road Planer and Finisher, portable rock crushers, stone elevators, screens and bins, motor rollers, dump cars, scarifiers, elevating graders, dump wagons, street sweepers, street sprinklers, pressure road oilers, road drags, wheeled scrapers, drag scrapers and road plows.

HOISTING BUCKETS AND TUBS—Catalog E, issued by the Brown Hoisting Machinery Co., Cleveland, O. 6x9 ins.; 64 pages. Illustrates and describes the Brown line of buckets and tubs used in hoisting and conveying loose materials.

BUILDING MATERIALS—Issued by the Philip Carey Co., Lockland, Cincinnati, O. A pamphlet illustrating and describing the Carey line of building materials, with special reference to roofing shingles, cement roofing, rubber roofing, ceil board for walls and ceilings, insulating paper, asphalt saturated felt and asphalt paints.

CONCRETE MIXER—Folder issued by the Blaw-Knox Co., Pittsburgh, Pa., featuring the Blaw-Ransomixer.

PERMANENT CONCRETE ROADS—Issued by the Truscon Steel Co., Youngstown, O. 5½x7½ ins.; 128 pages. Contains a history of concrete pavements and chapters on the concrete roads in Wayne county, Michigan, maintenance of concrete roads, etc., and shows the use in concrete road and pavement construction of Kahn reinforcing mesh, armor plates, curb bars, edge protectors, etc. Contains many good illustrations of concrete road construction operations.

CONSTRUCTION MACHINERY—Issued by Lakewood Engineering Co., Cleveland, O., as a general catalog. 6x9 ins.; 162 pages. Illustrates and describes concrete mixers, charging hoppers, steel hoisting cars, concrete chutes, clam shell buckets, miscellaneous buckets, contractors' cars, and a selected number of typical Lakewood installations which are illustrated and briefly described.

HOW TO MAKE AND HOW TO USE CONCRETE—Issued by the Ransome Concrete Machinery Co., 115 Broadway, New York City. 5x7½ ins.; 152 pages. Price, $1.00. The Ransome

line of machinery and concreting equipment is subordinated to those fundamental facts which make for success in the use of concrete. Written and compiled by H. Colin Campbell, C. E., director editorial bureau, Portland Cement Association.

TRADE NOTES

With the completion of the greatly increased facilities now planned, the Service Motor Truck Company, of Wabash, Ind., will have one of the largest and most modern truck factories in the country. The actual enlargement of the plant is now under way, and still further enlargement is planned when units now under way are completed. During a recent week domestic orders totaling more than a half million dollars were received. Contracts were recently let for the construction of two new buildings. They are of steel and brick construction and are now nearing completion. One is 50 by 450 ft. and the other is 75 by 200 ft. When they were planned last fall, their construction was considered adequate to care for the growth of the business for some time to come. The unexpected expansion of the trade, due more or less to freight congestion and the demand for trucks for intercity hauling, has shown in even that short a time that a still further increase of facilities is needed immediately.

When the units now under construction are completed the Service plant will have a capacity of twenty trucks a day. With the further additions soon to be started, the capacity will be more than doubled to allow for fifty trucks a day.

Forrest J. Alvin, general manager of the United States Motor Truck Company of Cincinnati, has completed arrangements with C. W. Moody of New York, A. W. Wyckoff of Pittsburgh and J. W. Boyd of Akron whereby these men will act as wholesale distributors for United States trucks in the New England states, Maryland, Pennsylvania, Virginia, North and South Carolina, New York and the eastern portion of Ohio.

J. F. Bowman, vice-president and general manager of the Acason Motor Truck Company of Detroit, is strongly in favor of a movement to bring about the loading of all trucks with merchandise when these trucks are being delivered by roads to dealers and distributors throughout America. Mr. Bowman believes that in this way much good will be done in relieving the freight congestion and in saving waste energy which comes about through driving the trucks through the country without load. There are being established in many parts of America what are known as reload bureaus and these organizations will gather together vast amounts of merchandise which may very easily be taken to destination by trucks which ordinarily would travel empty. Expenses of delivery of trucks would in this way be brought to a very low point, thus saving in the freight situation and also in the expenses of delivery.

H. T. Melhuish, a brother of William Fulton Melhuish, Jr., president of the Fulton Motor Truck Company of Farmingdale, L. I., has succeeded E. E. Vreeland as advertising manager of the company. Mr. Vreeland, who remains a stockholder in the Fulton company, recently became an officer of the Abbot & Downing company, at Concord, N. H. Mr. Vreeland is head of the Vreeland advertising agency of New York.

Finding the former name inadequate to cover its wider field of activity, the Trussed Concrete Steel Co. has changed its name to the Truscon Steel Co. In its early days, years ago, this company devoted itself exclusively to reinforced concrete, introducing many new reinforcing products, such as the Kahn bar, Floretyles, etc. For many years, however, the activities of this organization have expanded far beyond the concrete field, so as to include a large variety of steel products. Prominent among these might be mentioned the steel windows so widely used in building work, metal lath, pressed steel joists, all-steel buildings, inserts and other specialties. Fortunately, in selecting a name embracing all its present activities, this company can readily follow the trend of popular suggestion. For years the company has been generally known by the name "Truscon"—a simplified abbreviation of the longer name. For this reason "Truscon Steel Co." has been selected as the new name of the company. Aside from this simplification of the name of the Truscon Steel Co., there has been absolutely no change in the company, its organization or management in any way. Representatives, locations and everything about the company are identically the same. The new name is the Truscon Steel Company, with plant and general sales offices at Youngstown, Ohio, and representatives in principal cities.

PERSONAL ITEMS

M. E. Kelley, formerly assistant city engineer of Anaconda, Mont., has been appointed city engineer to succeed W. B. Vestal, Jr., who resigned to take a position in Spokane, Wash.

John S. Lewis, who for nine years was superintendent of water works at Youngstown, O., has resigned that position.

Dudley Chipley, engineer and superintendent of the municipally owned water works at Columbus, Ga., has also been appointed county engineer.

Fred G. Whaley, who for several years was city engineer of Chehalis, Wash., is now with the Washington State Bureau of Inspection, in the Department of Appraisal for Municipal Utilities, with headquarters at Tacoma, Wash.

Randolph Martin has been appointed county engineer of Ontonagon county, Michigan. He formerly occupied a similar position in Houghton county, Michigan.

H. L. Sweet has been elected city engineer of Okmulgee, Okla.

H. A. Perkins has resigned the office of city engineer of Leavenworth, Kans., which he had held for four years.

R. L. Sizer has been appointed city engineer of Cumberland, Md.

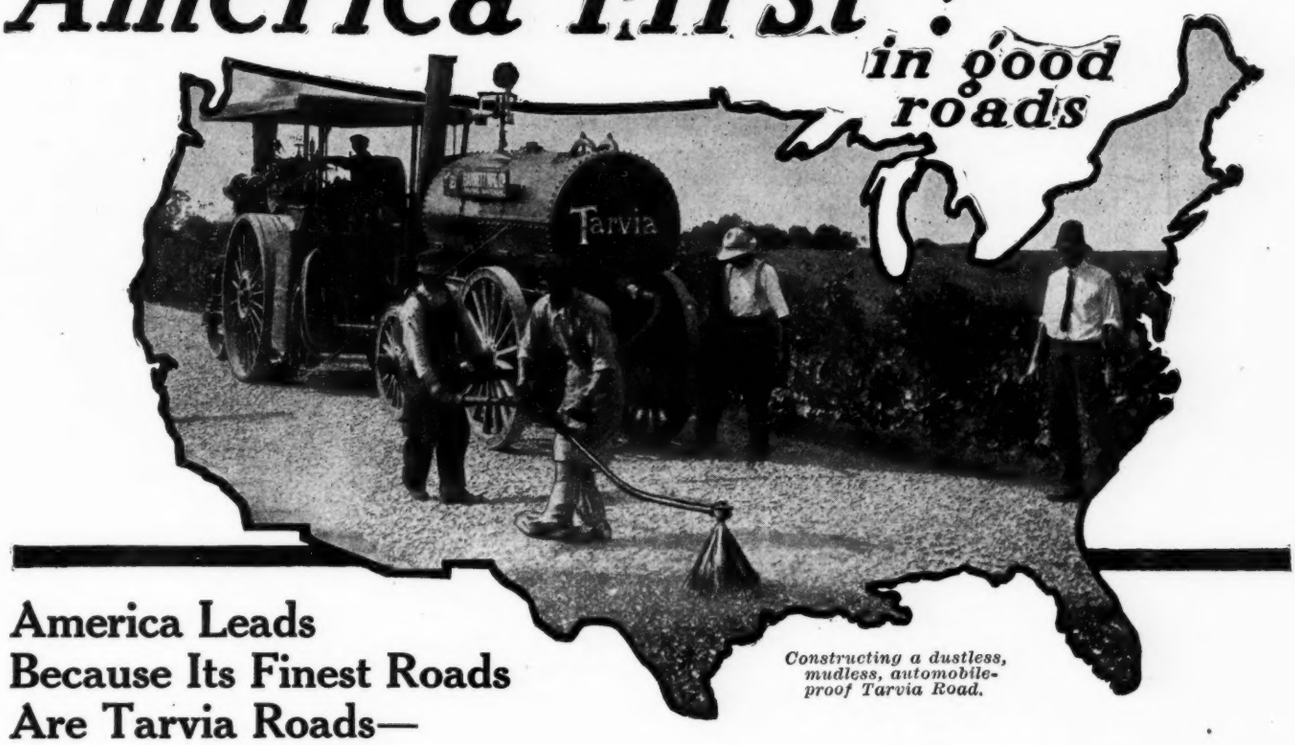
E. F. Johnson has been appointed city engineer of Virginia, Minn.

James E. Mast has been appointed civil engineer in the Bureau of Water of the city of Reading, Pa., to succeed J. Fred Whitman, who resigned.

H. Hilliard has been elected city engineer of Oldtown, Me.

J. N. Mackall, office engineer of the Pennsylvania State Highway Department, resigned that office on April 15 to accept his appointment by Governor Harrington as chief engineer of the Maryland State Roads Commission. Mr. Mackall was appointed office engineer of the Pennsylvania State Highway Department by former Commissioner F. E. Black. He graduated from Maryland State College in 1905, and immediately thereafter entered the service of the Maryland Geological Survey, where he remained until 1908, when he became connected with the Maryland State Roads Commission, which was organized at that time. He served continuously with the Maryland State Roads Commission up to March, 1917, when, on the recommendation of Chief Engineer W. D. Uhler, of the Pennsylvania State Highway Department, he was appointed office engineer. His engineering ability is indicated in many up-to-date methods which he introduced during his short term of service with the Pennsylvania Highway Department.

America First! in good roads



Constructing a dustless, mudless, automobile-proof Tarvia Road.

America Leads Because Its Finest Roads Are Tarvia Roads—

Twenty-five years ago, the roads of Europe were the best in the world.

Two centuries of incessant care had made them so smooth and firm that people thought they would never wear out. But along came the automobile, destructive alike to the roads and all road-building traditions.

The highways had not been constructed to bear this kind of traffic, and unless protected by modern methods they promptly went to pieces.

So Europe had to start even with America in developing roads that could withstand the gruelling test of the new conditions.

Now America leads.

The finest roads the world has ever seen are now constructed in this country, and a *very large part of these roads are built and preserved with Tarvia*

Tarvia roads are dustless and mudless, durable and automobile-proof. They give the maximum of wear at the minimum of maintenance expense.

Tarvia roads are an asset to any community because they make intercourse easier and increase property values.

They are an asset to the nation because they shorten the market haul and release labor for more productive work.

Now when we are at war and the railroads are clogged with traffic, *good roads are more necessrry than ever.*

With plenty of good roads, motor-truck traffic can take care of thousands of tons of food, fuel and munitions and relieve the railroads to a very great extent.

Every highway authority, every government official, should be interested in this problem *because good roads will help us win the war.*

Tarvia

Preserves Roads-Prevents Dust

Special Service Department

This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by any one interested.

If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will have prompt attention.

New York, St. Louis, Detroit, Nashville, Chicago, Cleveland, Birmingham, Salt Lake City

The Barrett Company

Philadelphia, Cincinnati, Kansas City, Seattle, Boston, Pittsburgh, Minneapolis, Peoria

THE BARRETT COMPANY, Limited: Montreal Toronto Winnipeg Vancouver St. John, N. B. Halifax, N. S. Sydney, N. S.

CONTRACT NEWS

CONTRACTS AWARDED

ROADS AND STREETS.

Ariz., Douglas—S. C. Contracting Co., city, award. contr. for paving G Ave. and 8th St., at $34,910 and $63,768, respectively.

Cal., Corte Madera—R. De Lucoa, local, award. contr. for improvt. of several streets, at $50,000.

Cal., Porterville—W. H. Paul, Stockton, award. contr. for paving Sunnyside Ave., Olive St., Putnam Ave., and S. Main St., at $100,000. Contract calls for 5-in. conc. and 1½-in. asph. wearing surface.

Cal., Riverside—Johnson-Shea Co., city, award. contr. for constr. of macad. rds. in Palo Verde valley, at $238,000; Johnson-Shea Co., award contract to construct macad. rd. to connect Govt. aviation field with Riverside-Perris rd., at $3,475.

Cal., Salinas—Granite Rock Co., Salinas, award. contr. for macadamizing 6 miles Salinas-Watsonville rd., at $37,262.

Cal., San Francisco—O. G. Ritchie, Chronicle Bldg., San Francisco, award. contr. for improvt. of Liberty and Sanchez Sts.; Fay Improvt. Co., Fay Bldg., award. contr. for improvt. of 44th St., Anza to Fulton, at $22,750.

Ct., Hartford—Francesco Valerio, Stamford, award. contr. by Hwy. Dept. for constr. of 38,527 linr. ft. crushed gravel rd., betw. Stafford and Willimantic, at $130,000.

Ct., Seymour—Lane Constr. Co., 356 Colony St., Meridian, Ct., award. contract for rd. constr. in Seymour, E. Windsor & Berlin, at $60,000, $33,000 and $14,000 respectively.

Fla., Bradentown—Manatee Co. Comrs. award. contrs. for bldg. 38 miles of rd. as follows: grading and shell wk. to R. A. Miller, 20c and $1.36 cu. yd. respectively, total $75,000; conc. work., to M. E. Turscham, at $30,000; Tarvia to Finley Method Co., at $74,000.

Ill., Chicago—Contracts for paving (grading, paving, adjusting sewer manholes, etc., etc.) award. to following: R. R. Anderson Co., Jno. Dillon Co., Peter J. O'Brien, R. F. Conway Co., Contracting & Material Co., American Asphalt Co., Jas. A. Sackley Co., A. N. Todd, J. A. McGarry Co., Central Paving Co., Standard Paving Co. This work is covered by Warrant Nos. 46405 to 46413; 46413 to 46423; 46330, 31, 39 and 40. Contracts for cement walks award. as follows: Simpson Constr. Co., Hanson Bros., H. Johnson & Co., Albert Graff, R. R. Anderson Co., Bairstow Supply Co., Jas. J. Ferry. Work covered by Warrant Nos. 27924, 28060, 28126, 28, 28, 28134, 28090, 81, 85, 28143, 44, 27899, 28100, 28037, 28158, 28162.

Ida., Burley—Warren Constr. Co., Portland, award. contr. for bithu. paving with gravel base, 5 in. thick, at $55,950.

Ill., Belleville—Kelley Bros., E. St. Louis, award. contr. for paving Belleville-Shiloh-Scott Field rd., at $55,920.

Ind., Anderson — Masters Constr. Co., Seymour, award. contr. for improving Pendleton Pike, at $71,583.

Ind., Indianapolis—Masters Constr. Co., Seymour, Ind., award. contr. for completing Pendleton Pike rd. improvt. in Lawrence Twp., at $71,584.

Ind., Terre Haute—Carpenter Constr. Co., city, award. contr. for constr. of James H. Swango rd., at $57,106; Lane Bros., local, award. contr. for McKeen rd., at $34,800.

Ind., Frankfort—Jesse E. Doane, local, award. contr. by Clinton Co. Commissioners, for constr. of 2½ mile brk road, at $57,000.

Ind., Indianapolis—Edw. Gant Constr. Co., award. contr. for improvt. of the H. E. Heine rd., in Franklin Twp., at $96,000.

Ia., Bettendorf—McCarthy Constr. Co., Davenport, award. contr. for paving 2d and 8th streets, at abt. $29,857; D. J. Ryan Constr. Co., award. contract for paving 10th St., at $18,467.

Kans., Wichita—Ritchie Bros. Constr. Co., Topeka, and Globe Constr. Co., Wichita, award. contracts for paving amounting to $90,000.

Me., Skowhegan—E. E. Greenwood and E. L. Ford, local, award. contr. for constr. of 3.54 mi. bitum. macad. rd., in Winslow, Ft. Halifax to Vassal Boro town line, at abt. $70,000.

Md., Baltimore—P. T. Cox Contracting Co., 154 Nassau St., New York, awar. contr. to grade and curb 3 blocks on St. Paul and Courtland Sts.—Lexington to Franklin—at $108,000.

Md., Baltimore—Chas. Herbold & Son award. contr. for remodeling south wing of Mt. Vernon Sq., and making changes around base of Washington monument, at $50,936.

Mass., Boston—E. C. Sargent, Quincy, award. contr. for bdlg. 11,900 ft. asph. macad. rd., 18 ft. wide; R. E. Bull, Fitchburg, award. contr. for bldg. state hwy. in Westminster Twp., at $22,180.

Mass., Boston—Bermudez Co., local, award. contr. for approx. 25,000 sq. yds. paving, at $55,600; Central Constr. Co., 228 Southampton St., city, award. contr. for relaying, with grout joints on conc. base, approx. 10,000 sq. yds. granite pavement on Dorchester Ave.; also relaying with gravel joints on gravel base abt. 2,000 sq. yds. granite blk. pavement, at $43,510; also contr. for sim. work (abt. 4,000 sq. yds.) in Dorchester Ave., So. Boston, and in and near Andrew Sq., also relaying with gravel joint on gravel base approx. 3,000 sq. yds. granite blk. paving in Southampton and Boston St., at $22,665.

Mass., Boston—Rd. contracts award. by St. Hwy. Comn. as follows: Becket, bitum. macad., 3 mi., to Cordner & Montague, 433 Bay St., Springfield, at $45,910; Palmer, widening and reconstructing bitum. macad. rd., 3 mi., C. Bianchi, S. Framingham, at $32,075; Beverly, 1.5 mi., Alco Constr. Co., Boston, at $19,055; Auburn, 1.75 mi., Lane Constr. Co., 35 Colony St., Meriden, Conn., at $25,990.

Minn., Minneapolis—General Contracting Co., local, award. contr. for paving 6.4 mi. of rd.—Robbinsdale to Osseo—at $182,250. Bithu.

Mich., Battle Creek—F. G. Schail & The Butler Construction Co., Milwaukee, Wis., have jointly been given contract to build new road betw. here and Camp Custer, at $73,000.

Mich., Lansing—Barnes & O'Neill, Allegan, award. contr. by State Hwy. Dept. for bldg. abt. 7 mi. of rd. in Ganges Twp., Allegan Co., at about $141,000.

Minn., Glenwood—E. A. Studer & J. Manion award. contracts for bldg. rds. in Nos. 1801 & 1805, involving 84,214 cu. yds. earth excav., head walls, hauling and placing of culverts—abt. $29,000.

Mont., Gt. Falls—S. Birch & Sons award. contracts aggregating expendt. of $44,197 by City, for paving, grading and sewer constructing.

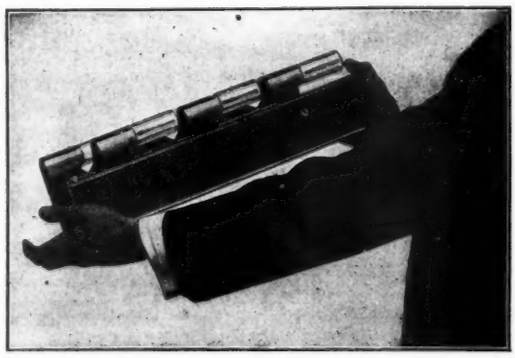
Neb., Lincoln—Roberts Constr. Co., local, award. contr. for grading and paving W. O St., at $197,807.

Neb., Nebraska City—Roberts Constr. Co., 510-11 1st Natl. Bk. Bldg., Lincoln, award. contr. for paving Federal aid rd.—P St. to where O. L. D. hwy. turns to O St.—3-in. brk. blks. on asph., 5-in. conc. base, at $97,807.

You Can't do Good Work with Poor Sand

You can find out the grade of your Sand quickly and cheaply by testing it with a

UNIVERSAL SAND TESTER



This simple and compact device will enable you to know *good* sand or *poor* sand *at once,* and give you a permanent record of the test.

It can be used in the laboratories, at the sand bank or on the job.

It costs but $40.00.

Mail us your order and we will ship promptly.

Booklet on application.

K TRADE MARK

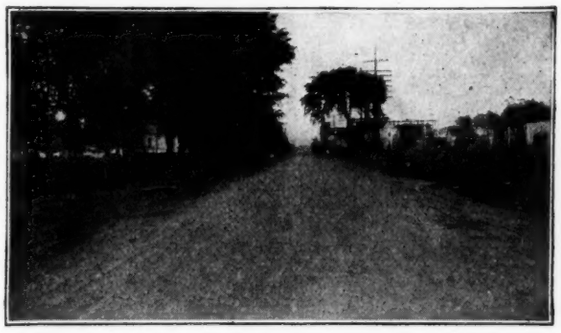
KOLESCH & COMPANY, 138 Fulton Street, New York

Sole Manufacturers.

THE STANDARD METHOD OF SURFACE TREATMENT

Stanolind Paving Asphalt is applied with a pressure tank wagon made especially for this work, as shown in illustration to the left.

Water Bonded Gravel Road after being treated with Stanolind Paving Asphalt at 300° F., 45 lbs. pressure, applied with special pressure tank wagon, one-half gallon to the square yard.



Water Bonded Macadam Road after being treated with Stanolind Paving Asphalt at 300° F., 45. lbs pressure, applied with special pressure tank wagon, one-half gallon to the square yard.

One application of Stanolind Paving Asphalt on macadam or gravel roads has given three years service with practically no expense. Builds more substantial surface at half the cost of light oil treatment for three years. Can be applied on roads previously treated with Road Oil.

Write today for free booklet *"Stanolind Paving Asphalt."*

STANDARD OIL COMPANY

(INDIANA)

910 Michigan Avenue **CHICAGO, ILL.**

N. J., Camden—Tidewater Bldg. Co. award. contr. for construction work in new town for shipbuilders of New York Shipbldg. Co., at abt. $2,000,000 to $2,500,000; Miles-Tighe Co. award. the contr. to lay out streets, parks, playgrounds, etc., etc., at $325,000. This city ready to expend $325,000 for bldg. school houses, fire stations, sewage & water plants.

N. J., Jersey City—Clinton Contracting Co., 306 Charles St., W. Hoboken, award. contr. for paving Palisades Ave., at abt. $51,000.

N. J., Paterson—W. A. Ferguson Sons, Little Falls, award. contr. for abt. 22,700 sq. yds. asph. conc. paving on stone base on Union Ave., at $87,910.

N. J., Trenton—Charles A. Reid Co., City, award. contr. for paving Brunswick Ave.—Bond St. to Paul Ave.—at $35,000.

N. Y., Geneva—Harry W. Roberts & Co., Utica, award. contr. for resurfacing S. Main, Seneca, S. Exchange, Linde, Sherrill and E. Castle Sts., with bithu. and sheet asph., at $54,777.

N. Y., Niagara Falls—Johnson Contracting Co. award. contr. for paving Lewiston Hill, at $30,751.

N. Y., Rochester—Greenfield Constr. Co., Hornell, award. contr. for bldg. 3.25 miles of state hwy., betw. Geneva and Canandaigua, at $54,071; Louf H. Gipp Constr. Co., Buffalo, award. contr. for rebldg. 4 miles betw. Batavia and Erie county, at $64,733.

N. C., Concord—R. M. Hudson, Atlanta, Ga., award. contr. for asph. paving by Comrs., Cabarrus Co., at $42,000.

O., Cincinnati—Geo. Murdock, local, award. contr. for improvt. of Hoffner St.—Colerain to Edgewood—at $32,285; Wagner & Boehning, contr. for improvt. of Arrow Ave.—Dryden to Wodmont—at $16,905.

O., Cleveland—Cleveland Trinidad Paving Co., Arcade Bldg., City, award. contract for grading & paving with 2-in. bithu. wearing surface on conc. fdn. West Blvd., at $50,000.

O., Columbus—O. M. Junk, Chillicothe, award. contr. for paving 2.23 mi. Baltimore-Reynoldsburg Rd., Fairfield Co., at $37,777.

O., Defiance—Johnson & Ritz, Napoleon, award. contract for paving Holgate Ave., 5th, Thurston and Summit Sts.; also Hopkins St. brdg. approach, at $72,412.

O., Mansfield—Richland Co., award. contr. for bldg. Mansfield-Lucas Rd., No. 300, to Ohio Conc. Supply Co., Fremont, at $35,207.

O., Medina—John Strumpf, Castalia, Ohio, award. contr. for the 2½ mile stretch of rd.—Lodi to Lafayette—at $46,830 for bitum. macad. road.

Okla, Okmulgee—Park-Moran Co., Okmulgee, award. contr. for laying 16 blocks of paving in Ponca City, at $200,000.

Ore., Astoria—J. H. Tillman Co., Portland, award. contr. to widen rd.—city limits to Matson Pl.—abt. 3 miles. Roadbed is to be widened to 30 ft., and graded ready for paving next spring. $21,307.

Pa., Harrisburg—Keystone Constr. Co., Meadville, award. contr. by State Hwy. Dept., for improvt. of important sect. in West Mead Twp., at $39,097. This section is on main hwy. connectg. Meadville and Titusville.

Pa., Harrisburg—Summit Construction Co., Akron, Ohio, award. contr. for improvt. of last link in connect. betw. industrial town of Vandergrift and Pittsburgh, at $123,199.

Pa., Harrisburg—Samuel Gamble Co., Pittsburgh, award. contr. for sect. of Route No. 108, Allegheny Co. (3.19 mi. long) at $170,340, rein. conc. block; E. H. Brua, Hollidaysburg, contr. for Duncanville Boro, at $39,746, vitr. block; Vipond Constr. Co., Altoona, contr. for improvement of Route No. 55—Bellwood to Tyrone—at $117,407, rein. conc. type; Stucker Bros. Constr. Co., Harrisburg, contr. for bldg. Oberlin Rd., Swatara Twp., Dauphin Co., at $22,573, vitr. block; Martin Bros., Pittsburgh, contr. for constr. of portion Hwy. Route No. 119, Youngstown Boro, Westmoreland Co., with rein. conc., at $23,145.

Pa., Harrisburg—Following contracts let by State Hwy. Department: R. I. Taylor, Bellefontaine, for constr. of 0.46 mi. vitr. blk. pavement Bellefonte Boro, at $26,885; Geo. H. Hardner, Allentown, for reconstr. of section of State Hwy. Route 159, at $72,315; C. S. King & W. E. Mungeld, Port Allegheny, for grading & draining 1.27 mi. State Hwy. Route 96, McKean Co., at $16,469; Irving S. Herton, Reading, for 0.86 mi. 2-course macad., Huntingdon Co., at $15,062, and 5.19 mi. 2-course waterbound macad., same Co., Lincoln Twp., at $77,340; B. G. Coon Constr. Co., Luzerne, for 1.15 mi. rein-conc. constr. in Montroe Boro, Susquehanna Co., at $38,250, & 1.23 mi. rein. conc. constr., New Milford Boro, same Co., at $30,145.

Pa., Pittsburgh—Austin & Matthews, Westview, awadr. contr. for 4.5 mi. Perry Hwy., rein.-conc., in Allegheny Co., at $158,213.

Pa., Washington—Wm. Pickett & Co., local, award. contr. for resurfacing Shaft Rd., one mile, at $27,325; Hardy & Rankin, Canonsburg, award. contr. for Canonsburg-Houston Rd., one-half mile, at $13,726; Donora Constr. Co., Donora, contr. for Charleroi-Bentleyville rd., one mile, at $25,625.

S. D., Vermillion—C. H. Atkinson Pavg. Co., Watertown, award. contr. for paving various streets with Portl. cem. conc., curb & grading, at $112,826.

Wash., Olympia—Spokane Bitum. Paving Co., award. contr. for 8 mi. of work on Central Washington Hwy—Sprague to Cheney—for $44,561; Quigg Construct., contr. for surfacing 12 mi. betw. Summit and Easton, at $41,368.

Wash., Olympia—Quigg Constr. Co., Wenatchee, award. contr. for east side division Snoqualamie pass route, at $41,368; Central Wash. Hwy. (8 mi.) out of Sprague, award. to Spokane Bitumas Co., at $43,060.

Wash., Seattle—Washington Paving Co., 309 First Ave., S., award. contr. for paving 7½ miles Yakima-Moxee City rd., at approx. $200,000; W. A. Kupoff, award. contr. for improving Sixth Ave., with wooden curbs and gutters, at $2,580.

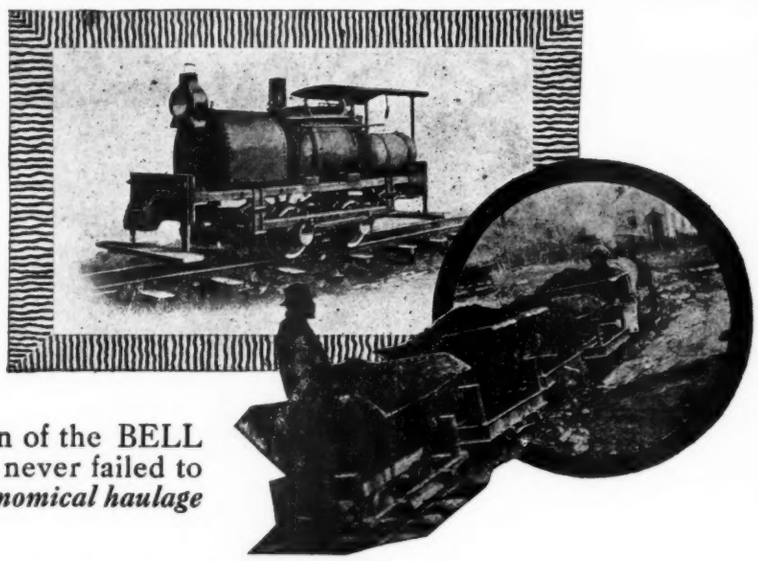
Wash., Spokane—Spokane Bithu-Mass Paving Co., award. contr. for bldg. Medical Lake permanent hwy., at $36,250. Rd. extends from Medical Lake north to Sunset Blvd., 4½ miles.

Wash., Spokane—C. M. Payne, Spokane, award. contr. for constr. of 3½ mi. conc. pavement on Normal rd.—Hazlewood south—at $16,062.

Wash., Yakima—A. J. Gudgel, Missoula, Mont., award. contr. for hard surfacing 4 miles Riverside Rd., at $86,383—39,080 sq. yds. 1-course conc.; Yakima Glazed Cement Paving Co., award. contr. for Perm. Hwy. No. 26-A—14,230 sq. yds. 1-course conc.—at $28,198.

Wis., Milwaukee—Stein Contr. Co., City, award. contr .for constr. of 2 miles conc. pavement on Port Washington Rd.—no end to county limit—at $115,608.

"The Chief Engineer says that the 5-ton BELL Locomotive they purchased in 1915 is a wonderful machine."



Wonderful—is a proper description of the BELL Oil Burning Locomotive. It has never failed to solve the problem of *quick and economical haulage* on any heavy contracting work.

Low—in first cost *(the BELL is inexpensive).* In upkeep cost *(only 19 moving parts in entire locomotive).* In fuel cost *(burns cheapest fuels—kerosene, fuel oil or crude oil).*

High—in speed *(12 to 15 miles per hour).* In power *(pulls 50 per cent heavier trains than direct connected locomotives of equal weight).*

The BELL Locomotive is simplest to operate.
Read all details in Bulletin.

BELL LOCOMOTIVE WORKS, Inc.

11 Pine Street **(Founded 1908)** **NEW YORK CITY.**

BELL Locomotives are built narrower, lower and shorter. Sizes—2 to 18 tons. Send for specifications and prices.

DU PONT AMERICAN INDUSTRIES

Fire Charges with Electricity

To Increase the Efficiency of Explosives, Reduce the Liability of Accidents and Save Time and Labor

The use of Blasting Machines enables several shots to be fired simultaneously—this united action increases the efficiency of explosives.

The location of Blasting Machines in places of safety reduces the liability of accidents.

Several shots can be fired at one performance—saving the labor and time necessary to detonate single charges.

Ask for Blasting Supplies Catalog. Use the coupon to learn about other Du Pont Products.

Note:
When in Atlantic City, visit Du Pont Products Store. Boardwalk and Penna. Ave., and the Shooting School on Ocean End of Young's Million Dollar Pier.

E. I. du Pont de Nemours & Co.
Powder Makers Since 1802 Wilmington, Delaware

The Du Pont American Industries Are:
E. I. du Pont de Nemours & Co., Wilmington, Del., Explosives.
Du Pont Chemical Works, New York, Pyroxylin and Coal Tar Chemicals.
Du Pont Fabrikoid Co., Wilmington, Del., Leather Substitutes.
The Arlington Works, 725 Broadway, New York, Ivory Py-ra-lin and Cleanable Collars.
Harrison Works, Phila., Pa., Paints, Pigments, Acids, Chemicals.
Du Pont Dye Works, Wilmington, Del., Dyes and Dye Bases.

MAIL THIS COUPON
Marking X before subject of interest, to
E. I. du Pont de Nemours & Co.
Adv. Div. (E. I. 76) Wilmington, Del.

☐ Blasting Supplies	☐ Fabrikoid, Motor
☐ Blasting Powders	☐ " Craftsman
☐ Industrial Explosives	☐ " Book-Finish
☐ Sporting Powders	☐ " Sheeting
☐ Trapshooting	☐ " Truck Spec'l
☐ Gun Clubs	☐ " Marine Spec'l
☐ Harrison Paints	☐ Fairfield Rubber Cloth
☐ Vitrolac Varnish	☐ Py-ra-lin Specialties
☐ Flowkote Enamel	☐ Py-ra-lin Toilet Goods
☐ Auto Finishes	☐ Py-ra-lin Sheeting
☐ Sanitary Wall Finish	☐ Py-ra-lin Enamels
☐ Antoxide Iron Paint	☐ Challenge Collars
☐ Bridgeport Wood Finish	☐ Ethers
☐ Metal Lacquers	☐ Commercial Acids
☐ Pigment Bases	☐ Bronze Powder
☐ Wood Lacquers	☐ Tar Distillates

NAME .....
ADDRESS .....
PLACE .....
BUSINESS .....

DU PONT

Mathews Gravity Brick Conveyers

Performance counts! In the May, 1918, issue of *Municipal Engineering* these paving contractors tell what they have done with Gravity Brick Conveyers—

C. W. Hughes, Malta, Ohio, placed 32,000 paving brick in one day with eight men! H. K. McCollum, Fort Worth, Texas, placed 30,000 to 50,000 per day with ten men! McAlonan Bros., Akron, Ohio, laid 40,000 a day with fourteen men! A. C. Loomis Co., Mattoon, Ill., laid 30,000 brick per day with ten men! Henderson Bros., Coshocton, Ohio, placed 40,000 brick in one day with eight men!

All contractors report that Mathews Gravity Carriers save rehandling the brick, give them the right number of brick at hand, obviate chipping and breaking of brick, bring the brick to the setters clean and keep mud off the newly laid brick; also that the Conveyer is easy to adjust to fit various widths of streets.

Investigate the MATHEWS—Send for Bulletin 4.

MATHEWS GRAVITY CARRIER COMPANY
ELLWOOD CITY, PA.

SEWERAGE AND SEWAGE TREATMENT.

Ariz., Jerome—Wm. B. Arndt & Merkle, P. O. Box 655, City, award. contr. for constructg. sewer sys. & treat. tank, at $32,296.

Cal., Anaheim—C. McNeil, Santa Ana, award. contr. for constr. of rein. conc. Imhoff tank for city sewage disp. sys., at $4,137.

Cal., Calexico—Bush Constr. Co., local, has been sublet contr. by G. R. Daley, local, for constr. of san. sewers, at abt. $18,000.

Cal., Long Beach—J. Wost, 2152 Reservoir St., Los Angeles, award. contr. for bldg. 27,500 lin. ft. cem. pipe sewers, etc., in Sew. Dist. No. 7, at $31,487.

Cal., Los Angeles—Leo Miletich, City, award. contr. for constr. cem. pipe sewer in Cahuenga Ave., at $1,436; in Ivar Ave., at $1,148; Hollywood Blvd., at $392; Normandie Ave., at $1,476; Fayette St., at $1,345; C. H. Johnston award. contr. for constrg. cem. pipe san. sewer in Denison Ave., San Pedro, at $1,500; Joe Zelko, City, award. contr. for cem. pipe sewer in Buchanan St., at $1,052; Jos. D. Zaich, low bidder for cem. pipe san. sewer in Norton Ave., at $1,784; Yovo Kunjunzik, City, award. contr. for cem. pipe san. sewer in Stratford Rd., at $1,858.

Ct., Bridgeport—Forelone & Romano, Portland, Me., award. contr. for bldg. complete sewer sys. for Hollister Heights, sect., at $178,000.

Ct., Stratford—Forgione E. Romano Co., Portland, Me., award. contr. for sewer sys. as follows: Sect. 1, at $103,232; Sect. 2, Segm. tile, at $74,997.

Ida., Burley—Warren Construction Co., Portland, award. contr. for construction of storm sewer, at $12,498.

Ida., Rupert—B. M. Barsden & Co., Butte, award. contr. for sewer constr. in Dist. No. 1, at $82,000.

Ill., Antioch—J. Dupree, Antioch Bldg., award. contr. for rein. conc. septic tanks and sand filter beds, at $15,999.

Ill., Chicago—Following contracts award. for constr. of tile pipe sewers in following streets & avenues: So. Bishop St.—W. 112th pl. to W. 113th—to Simon Ryan; Yale Ave.—W. 80th to 81st St.—to Alfonso Scully; in alley 1st So. of W. 16th St.—S. Wood to 400 ft. east—to Angelo Mancini; S. Bishop—W. 59th to W. 60th—to Malachy Murphy; Crandon Ave.—E. 83rd to E. 81st—to Geo. Pontarelli; Merrill Ave.—E. 90th St. to 160 ft. No. of E. 93rd St.—to Christ Anderson; So. Richmond St.—W. 55th to W. 57th—to P. J. McNulty Co.; West side Stony Isl. Ave.—E. 90th St. to E. 87th—to Geo. Pontarelli; sys. sewers in Crandon Ave.—E. 90th to E. 92nd, and E. 92nd—alley 1st west of Yates to alley 1st east of Luella Ave.—to Angelo Mancini; sys. in W. 73rd—So. Robey to 500 ft. west So. Hoyne; So. Selley—W. 71st to W. 73rd; S. Hoyne—W. 73rd to W. 72nd; West 72nd—S. Hoyne Ave. to 470 ft. west of S. Hoyne; W. 72nd Pl.—S. Hoyne to 470 ft. west So. Hoyne Av.—to P. J. McNulty Co.

Ill., Pinckneyville—D. E. Bipp, Floyd, Ill., award. contr. for installing sewer, at $37,000.

Ind., East Chicago—Shea & Co., Hammond, Ind., award. contr. for constrg. Catalpa street sewers, at $4,982.

Ia., George—Arthur A. Robson Co., Lincoln, Neb., award. contr. for construction of sewerage sys., at $16,700; Ward & Weighton, Sioux City, contr. for disposal plant, at $5,925.

Kans., El Dorado—Jesse Henry, local, award. contr. for sewer in Dists. 30 to 35 inclusive, at $10,844.

Ky., Covington—O'Hearn & Metzel, 316 Overton St., Newport, award. contract for bldg. sewer in 39th St., at abt. $15,000.

Ky., Louisville—K. A. Barker, L. R. Figg, L. W. Hancock and H. Bickel Co., 443 Garnde St., award. contr. by Bd. Pub. Wks. for bldg. 8 sewer extensions through streets and alleys, at $29,500.

La., Shreveport—R. N. McKellar, award. contr. to construct King's hwy. storm sewer, at $2,425.

Minn., Duluth—Pastoret Constr. Co., Virginia, Minn., award. contr. for constr. of rein. conc. segment and block storm sewers in Woodland Ave.—bet. Minneapolis Ave. and Austin street—at $27,164.

Mich., Ford—Lennane Bros., Union Trust Bldg., Detroit, award. contr. by City, to build sewers, at about $66,000.

Mont., Poplar—C. H. Kelley, City, award. contr. for constr. of sewer system, at $54,131.

N. J., Washington—Suburban Engrg. Co., 15 W. 38th St., New York City, contract for enlarging sewage disp. plant, including addn. septic tank, and enlarging sludge beds, at $10,956.

N. J., Wrightstown—Monmouth Constr. Co., Broad street, Red Bank, N. J., award. contr. by town for bldg. new sewerage sys., at about $26,540.

N. Y., L. I. City—J. L. Sigretti, 1455 Woodhaven Ave., Long Island City, award. contr. by Pres. Queens Boro, for bldg. sewers and appurtenances in Jamaica, Metropolitan, Van Cott, Oxford and Van Wyck Aves., Broad, Hill, High, Charles, Billbyn, Gerold and Hickory Sts., Wissner Pl.; also bldg. appurtenances on Ely, Forest, Cooper & Lotus Aves., Temple & Summerfield Sts.; also temp. sewer and appurts. in Union Hall St., 2nd, 3rd and 4th wards, at $15,525.

N. D., Wahpeton—H. J. Connolly, local, award. contr. for constructing sewers, at $4,812.

O., Akron—G. P. Hoffman, Director Pub. Serv., award. contr. to Shulls Bros. Co. for laying 13,703 lin. ft. 6-12 in. c. i. pipe and replacing 80 sq. yds. brk. and 230 sq. yds. asph. pavement, at $13,517.

O., Cleveland—River Constr. Co., 12109 Mayfield Rd., award contr. by city for bldg. 2,700 ft. vitr. sewers with manholes and catchbasins in E. 105 St.—Westchester to Adams Aves.—at abt. $24,585.

O., Cincinnati—M. J. Connelly Co., City, award. contr. for sewer constr. in Liston Ave., Colfax Ave., right-of-way & Railroad Ave., at $41,095.

O., Rocky River—Bomberger-Weiger Co., Sandusky, Ohio, award. contr. for constructing disposal plant, by village council, at $83,000.

O., Toledo—Peter Bros., City, award. contr. by Service Direct. Goodwillie, for san. sewer in Pomeroy's Stickney Ave. Park, at $8,817.

Okla., Miami—Paine Constr. Co., award. contr. for constr. of san. sewer system, at $20,300.

Pa., Throop—Sweeney Bros., Miller Bldg., Scranton, Pa., award. contr. for installing 6 mi. of t. c. pipe sewer, 10 to 1 ins. diameter and necessary manholes, at $100,000.

Wis., Kenosha—E. H. Prange, Grand Rapids, award. contr. for installg. trunk sewers, at $80,733.

Wis., Niagara—J. J. Connolly, 1007 Reany St., St. Paul, Minn., award. contract for bldg sewerage & water sys., at abt. $38,475.

WATER SUPPLY AND PURIFICATION.

Cal., Oxnard—Leonardt & Peck, 721 H. W. Hellman Bldg., Los Angeles, award. contr. for constr. of 3 rectangular rein. conc. reservoirs for Am. Sugar Beet Co., at $62,000. Each reservoir will be 320x320 ft., and 11 ft. deep, connected. There will be about 400,000 sq. ft. paving & 6,000 bbls. cem.; 66 tons rein. steel. Reinforcement will consist of ¼-in. round steel rods. Plans by Engrg. Dept., above Company.

Cal., Orange—Frank W. Dimmock, Santa Ana, award. contr. for drilling well for city water sys., at $5,161.

Cal., Pasadena—Clampitt & Moss, Los Angeles, award. contr. at $7,500 for drilling deep well at Windsor Ave. pumping station.

Cal., Santa Barbara—Bent Bros., Los Angeles, award. contr. for constr. of Gibraltar dam & accessories on Santa Ynez River near Santa Barbara, for municipal water system, at $342,981. Quinton, Code & Hill, Hollingsworth Bldg., Los Angeles, Consit. Engrs.

Cal., Sierra Madre—Byron-Jackson Iron Wks., 352 Market St., San Francisco, award. contr. for installing pumping machinery, in city well No. 2, at $6,389.

Ida., Twin Falls—Six contracts for new Water System as follows: Contr. No. 1—Bldgs. & conc. wk—Husser-Packard Co., Salt Lake City, $72,700; Contr. No. 2—B & S pipe, 16 ft. metalium joints—Wm. Harkins, City, at $42,630. Contr. No. 3—Filter Equip., high velocity wash & 6,000,000 gals. capy.—Pittsburgh Filter Mfg. Co., Pittsburgh, Pa., $60,627; Contr. No. 4—Cast iron pipe—American Cast Iron Pipe Co., Kans. City, Mo., $54,300; Contr. No. 5—Steel pipe—No bids received; Contr. No. 6—Wood pipe, Dist. System—Redwood Mfg. Co., San Francisco, Cal., $57,579; Contr. No. 7—Hydrants & valves—Renselaer Valve Co., Seattle, Wash., $11,074.

Ill., Chicago—Tiritilli & Till, City, award. contrs. for water supply pipes in S. Bishop St.—W. 112th Pl. to 113th Pl.; in N. Moody Ave.—W. Grand to Armitage Ave.; in Throop St.—D. 83rd to W. 84th St.; Simon Ryan, City, contracts for pipe in N. McVicker Ave.—W. North to W. Bloomingdale Ave.; in Olympia Ave.—Avondale Ave. to 210 ft. So. Otsego Ave.; in Wentworth Ave.—W. 123rd to W. 125th St.; Malachy Murphy, contracts for system of streets—W. 82nd Pl., W. 83rd, W. 83 Pl., W. 84th St., So. Hamlin Ave., W. 84th Pl., So. Hamlin Ave., etc., etc.; Daniel Hardin, contr. for water serv. pipes in No. one-half W. 67th St.—So. Calif. Ave. to So. Troy St.

Ind., South Bend—D. L. Davis, Mishawaka, award. contr. for repair work of central pumping station dam; cost betw. $15,000 and $20,000.

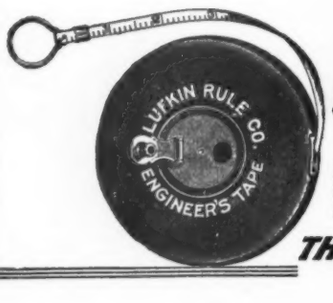
Kans., Ogden—Everett Construction Co., Hutchinson, Kans., award. contract by city for improvement of water works and sewerage systems, at abt. $18,000.

Mass., Boston—Hugh McMulty, local award. contr. for laying & relaying water pipes in Tremont & Cufflin Sts., Bright; also establishing gates in Washington St., Brighton, at $2,739; Robert Eagar, Jr., local. award. contract for laying & relaying water pipes in Highland St., Milton Ave., Norway Park, Neponset and Dana Aves., Summit & Washington Sts., Hyde Park, at $5,252.

Mass., Brookline—B. M. Dillon Steam Boiler Wks., Fitchburg, award. contr. for 2 horizontal tubular boilers for low pressure water serv., at $5,920.

Faultless Service in Every Respect THAT'S WHAT YOU NEED WHEN TAKING MEASUREMENTS

That's what you can rest assured you are getting when you use



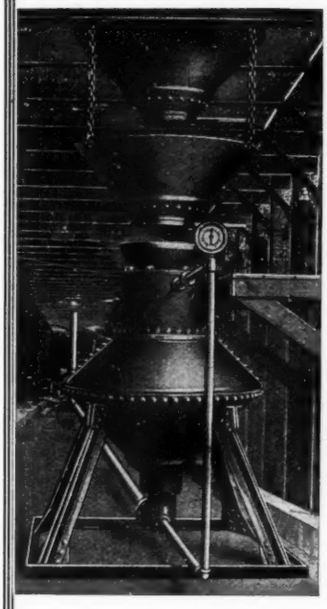
LUFKIN TAPES

PIONEERS IN CONNECTION WITH THE NOTEWORTHY IMPROVEMENTS MADE IN TAPES

More of them are in use than all other makes because they have for years consistently maintained the highest reputation. **Send for Catalog No. 26.**

THE LUFKIN RULE CO. SAGINAW, MICH.
NEW YORK. LONDON, ENG. WINDSOR, ONT.

From Mixer to Forms



A fine, uniform batch direct from the mixer to the forms—no matter how far distant the job *or how difficult!*

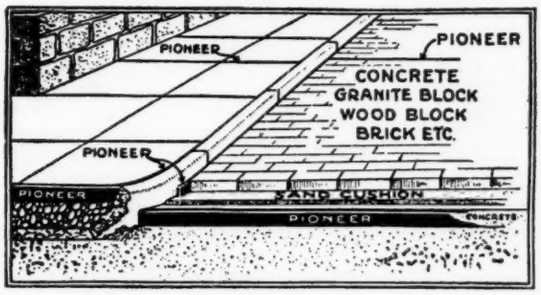
The New Pneumatic Process

is its own *mixer, conveyor and placer.* It discharges the concrete *right to the spot* through a flexible 4-inch or 6-inch pipe. The flow is smooth and continuous. No barrow gangs to hold up the job—no cableways, towers or derricks to get out of order.

Write for full particulars about this *advanced* method of mixing and conveying concrete.

Pneumatic Concrete Machinery Co.
2 Rector Street New York City

No Bulging!



PIONEER Pure Asphalt Expansion Joints

Long service proves that where **Pioneer** Joints are used pavements *never bulge,* even under the most extreme expansion conditions.

A perfect bond with the sections of the pavement—completely filling the interstices when the pavement contracts—is *always sure* when you use **Pioneer** Joints. Tough, pliable, made from purest asphalt filler.

Write for prices and particulars of the whole list of Pioneer Products.

The Pioneer Asphalt Company
Chicago Office: 7323 Woodlawn Avenue
Factory: Lawrenceville, Ill.

CONCRETE FOR PERMANENCE

Concrete roads are tax reducers

Highway maintenance consumes much of the money that comes out of taxes. Highway maintenance is *expensive!*

Compare the upkeep of concrete roads with that of other roads—the average concrete road costs only ***about $30 per mile per year to maintain.*** Concrete roads will outlast the bonds that pay for them.

Build concrete roads. Save the difference in after-costs for other improvement or reduction of taxes.

Write for "Concrete Highway Construction."

The Atlas Portland Cement Co.
Mem' - of the Portland Cement Association
New York Chicago Philadelphia Boston St. Louis
Minneapolis Des Moines Dayton Savannah

PORTLAND ATLAS CEMENT
"The Standard by which all other makes are measured"

Cutting the Cost of Culverts
and Culvert Building

Means and methods of accomplishing these very desirable savings are described in the booklet illustrated above, which will be sent to any one without obligating him in the least.

This booklet is published *for distribution.* If you are interested directly or indirectly in culverts or culvert construction, it will be well worth your while to read this illustrated treatise on the subject, and we will be pleased to send it to you on request.

Storms Manufacturing Co.
52 W. VanBuren St. CHICAGO, ILL.

Minn., Minneapolis—City will lay c. i. water mains on 7 streets by day labor. Abt. $30,845; also on W. 43rd and 3rd Sts., N. Irving Ave., N. Humboldt Ave., N. Wentworth and Blaisdell Aves., abt. $47,735.

N. J., Lodi—Salvatore Guardalibeni, award. contr. for constr. new pumping sta., by Fire & Water Comm., at $13,935.

N. Y., Albany—Jarcho Bros., 22 E. 105th St., N. Y. City, for installing water supply sys. & plumbing in term. freight shed at Pier No. 6, East River, at $8,650.

N. Y., Jamestown—Chapman & Graham, Jamestown, award. contr. for bldg. receiving well and pump pit for new sub-pumping station to be erected in Cassadaga valley, abt. one mile north of Falconer, at $30,384.

O., Akron—T. E. McShaffrey Constr. Co., City, award. contr. for bldg. pumping plant on Wooster Ave., at $11,205; Philip Agrios, Akron, award. contr. for laying water pipes in Bisson, East, Hodge and Wooster Aves., at $18,791.

Ore., McMinnville—V. A. Dennis Constr. Co., local, award. contr. for constructing rein. conc. reservoir and pipe line for McMinnville water sys., at $18,900 for the reservoir and $16,815 for pipe line.

Wash., Seattle—D. H. Trephagen, award. contracts aggregating $75,000 for work at Westholme in W. Seattle. Contract includes laying 9,000 ft. 8-in. water main.

Wash., Vancouver—Wilde Pump Co., City, award. contr. for constructg. water sys. of the spruce dry kiln and spruce cut-up plant in Vancouver Barracks, including drilling 4 wells, 40 ft. deep, and installing pumps, capy. 4,800 gals. an hour, at $6,000.

Wis., Sturgeon Bay—P. P. Nebel, local, award. contr. for pumping station 24x18, brk. constr., at $16,663.

Wyo., Rawlins—L. B. Bebbergall, Medicine Bow, award. contr. for drilling and casing well, at $3,600.

BRIDGES AND BUILDINGS.

Ark., Blytheville—Laughlin & Nailing, Luxora, award. contr. for constr. of hwy. bridge, wooden struct. with draw span, over Little River, at $17,350.

Ark., Forrest City—M. Kelly, Little Rock, award. contr. by Bd. Comrs., St. Francis Co., Rd. Improvt. Dist. No. 3, for bldg. 4,500 ft. wooden pile bridges, at abt. $12,130.

Cal., San Francisco—J. Sprago, 240 Montgomery St., San Francisco, award. contr. for bldg. conc. foundations for viaduct across Embarcedero at ft. of Market street, at $11,200.

Cal., Santa Rosa—W. L. Proctor, award. contr. by Bd. of Supvrs. for construction of 2 rein. conc. bridges over Petalume Crk. on state highway, at $10,960.

Colo., Glenwood Sprgs.—C. W. Anderson, Grand Jct., Colo., award. contr. by city for replacing Lacy brdg., at abt. $15,000.

Ct., Hartford—C. H. Slocomb, City, award. contr. for Capitol Avenue extension bridge, at $31,129.

Ida., Lewiston—Security Brdg. Co., local, award. contr. for constr. of wagon brdg. over Clearwater river at Peck, at $25,000. Bridge will be 530 ft. long, comb. struct. of steel, conc. piers, etc.

Ida., Peck—Peck Bridge Co. has award. Security Bridge Co., Lewiston, contr. for steel bridge 530 ft. long, conc. piers, over Clearwater river, at $25,000.

Ida., Sandpoint—Illinois Steel Co., Hutton Bldg., Spokane, Wash., award. contr. by Bonner County for bldg. Clarksford brdg., at $94,000.

Ill., Joliet—Ralph Newkirk, City, award. contr. for constructg. one rein. conc. brdg. & abutments in Will Co., at $4,555.

Ill., Newton—Porter-McMully Constr. Co., Georgetown, award. contr. by State Hwy. Comr., Springfield, for bldg. Crockett brdg., at $14,698.

Ill., Springfield—Porter-McCully Construction Co., Mackinaw, Ill., award. contr. for Crockett Brdg., Sect. F, Jasper Co., at $14,998; Ralph Newkirk, Joliet, Ill., award. contr. for constr. of Bissell brdg., Will Co., at $4,555.

Ind., Bluffton—J. A. Crosbie, Bluffton, award. contr. by Wells Co., for bldg. 18 bridges, at abt. $25,880.

Ind., Ft. Wayne—Stone & Smith, award. contr. by Allen Co. for bldg. 7 bridges, at $5,252; C. W. Ehling, 5 bridges, at $11,477; J. Sweet, 5 at $6,240; G. Jaap, 5 at $5,673.

Ind., New Albany—E. St. Louis Brdg. Co., E. St. Louis, Ill., award. contract for constructg. 5 steel and conc. bridges, at $8,950.

Ind., So. Bend—Hilton Hammond, award. contr. for bldg. bridge on Main Market Hwy., over Baugo Crk., at $11,830. Bridge will be of concrete.

Ind., Terre Haute—National Conc. Co., 823 Lemcke Bldg., Indianapolis, award. contr. for bridge on National Rd., at $4,799.

Ia., Albia—J. A. Lafferty, Eddyville, award. contr. by Monroe Co., for bldg. bridges and culverts, at about $18,000.

Ia., Cedar Rapids—Perry Jayne, Cedar Rapids, and Jas. P. Riddle, Creighton, Neb., award. contracts for county bridges as follows: Nos. 1, 2, 7, 11, 12, 13 & 14, to Perry Jayne, at $2,050, $3,415, $1,940, $4,650, $900, $3,030, $1,292, $1,610, $1,050, $18,200, $732, $875, $750, $500, etc., etc.; 3, 4, 5, 6, 8, 9 & 10 award. to Riddle: $3,668, $1,892, $4,065, $899, $2,808, $1,427, $1,273, $866, $15,200, $803, $1,072, $840, $515, $37,413, etc., etc.

Ia., Clinton—John R. Kane, Charlotte, award. contr. for 1918 bridge wk., at $33,759.

Ia., Dakota City—C. A. Miller, Humboldt, & C. Johnson, Humboldt, award. contracts for bldg. 37 conc. box culverts, 1 pony truss span, 3 beam spans & 4 conc. slab spans, at $27,856 & $8,500, respectively.

Ia., Elkader—Rodeis & Bahs, Strawberry Point, award. contr. for bldg. 287 ft. open spandrel arch & deck girder brdg. with 2 140 ft. steel truss spans & 1 conc. slab span, at $26,805.

Ia., Marshalltown—Iowa Bridge Co., award. contr. by Poweshiek Co., for bridge construction, at $22,375.

Ia., Montezuma—Iowa Brdg. Co., Des Moines, award. contr. for 7 concrete bridges, at $24,950.

Ia., Toledo—A. P. Mimsen, Marion, award. contr. by Tama Co., for bldg. 1 double pony truss brdg., 3 I-beam brdgs., 1 slab brdg. & 8 rein. conc. culvts., at $30,000.

Ky., Paducah—E. St. Louis Brdg. Co., E. St. Louis, Ill., award. contr. for bldg. bridge across Massac Creek on Paducah-Metropolis Rd.; est. cost $30,000.

La., Monroe—I. H. Scruggs Constr. Co., Amer. Trust Bldg., Birmingham, Ala., award. contr. by Ouachita Parish for bldg. rein. conc. brdg., 350 ft. long & 20 ft. wide, over Bayou De Siard, at $13,260.

La., Oberlin—Smith Bros. & La Roe, Palestine, Tex., awarded contr. for rd. & bridge constr., at abt. $75,000.

La., Shreveport—Blodgett Constr. Co., City, award. contr. for struct. metal work of lift span & tower & machinery for Market St. brdg., at $17,927.

La., Shreveport—Fox & Redpath, Kans. City, award. contr. for constr. of Market street brdg., over Cross Bayou, at $75,963.

Maine, Augusta—State Hwy. Department award. following bridge contracts: bldg. bridge in Shapleigh, to Sanders Engineering Co., Portland, at $3,556; bridge at Vassalboro, to Edmond Cyr & Co., Waterville, at $2,419; bridge in Abbott, to same firm, at $13,989; also bridge at Monticello, at $43,490.

Me., Abbott—Edmond Cyr & Co., Waterville, Me., award. contr. for constructing rein. conc. girder bridge 100 ft. long, 72 ft. wide and 20 ft. rdway. Two 52-in. rein. conc. piers & abutments, at $13,989.

Me., Perry—L. C. Wilbur, Bangor, award. contr. for bridge and earth approach, by Comrs., Washington Co., at $15,300.

Mich., Jackson—E. J. Tobin, City, award. contr. for constr. of conc. bridge over Grand River, at $29,980.

Minn., Montevideo—J. Molin & Son, 677 Sherburne Ave., St. Paul, award. contr. by Chippewa Co., for bldg. 8 bridges, at $24,652; contract for culverts, to Winona Conc. Culvert Co.

Minn., Shakopee—W. S. Hewitt, 741 Metropolitan Bk. Bldg., Minneapolis, award. contr. for State Brdg. No. 2442, on State Rd., No. 7, 200 ft. 24-ft. rdway. conc. flr. on conc. fdn., at $11,923.

N. Y., Albany—Walter S. Rae, Oliver Bldg., Pittsburgh, award. contr. for bldg. swing bridge over lock No. 2 at Fulton, N. Y., Oswego Canal Sect. 1, at $36,514.

O., Columbus—Cormichael & Cryder, Rialo Bldg., City, award. contr. by Franklin Co., to construct 7 arch rein.-conc. bridge on W. Broad St., at abt. $628,093.

Okla., Okla. City—M. E. Crawford, C. F. Scott, C. G. Landon, Boardman Co., and A. F. Alward Luther, award. contracts for 25 bridges, at abt. $38,000.

Ore., Portland—Parker & Banfield, City, award. contr. for constr. of rein. conc. brdg. at Hood River, at $53,915.

S. C., Charleston—Austin Bros., 156 Greenwood Ave., Atlanta, award. contract by Charleston Co., for bldg. steel & conc. bridge over Church Crk., at abt. $10,000.

S. C., Spartanburg—Luten Brdg. Co., Knoxville, Tenn., and O. S. Minus, Asheville, award. contracts to construct 7 brdgs., at $26,931.

Means Planned to Aid Motor Truck Routes

One of the important features of the movement will be the establishment in each of the terminal cities of "Return Loads Bureau," the business of which will be to provide loads for the trucks to haul back to their home towns after having made a trip one way.

Urged by the Government

A TRUCK THAT HAULS A LOAD FROM BLANKVILLE to your City will phone your "RETURN LOADS" BUREAU and obtain information as to where a load could be obtained for transportation on the return trip.

TAKE THE MATTER UP WITH YOUR CHAMBER OF COMMERCE. Correspondence with the Highway Transport Committee shows that the government is encouraging the establishment of motor truck routes throughout the country for the movement of freight, the hope being that such a system will result in relief to the rail transportation difficulties of the present time.

"WHY"

Genuine Berea Sandstone Curbing

IS SO EXTENSIVELY USED

BECAUSE:

It is *Nature's* formation
It is durable—lasts generations
It adds beauty to your streets
It does not disintegrate nor decay
It defies the elements
It has character
It is *dependable*
It is sold at a reasonable price

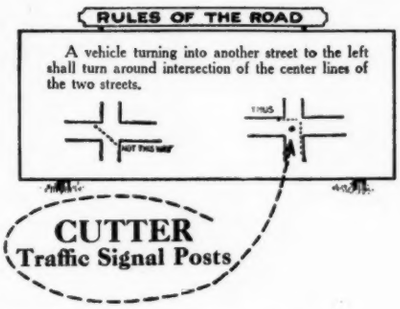
THE CLEVELAND STONE CO.

PRODUCERS

MAIN OFFICES:
Leader-News Building CLEVELAND, OHIO.

WESTERN OFFICES:
522 Marquette Building CHICAGO, ILL.

A Right Angle to the "Right of Way"


RULES OF THE ROAD
A vehicle turning into another street to the left shall turn around intersection of the center lines of the two streets.

CUTTER
Traffic Signal Posts

There's no doubt of the meaning of the bulging ruby glow. It *reminds* of the law and *enforces* it. No chances for misunderstanding this *pillar of safety.* It spreads its warning far out through *atmosphere and fog.*

To uphold the rules of the road,
Cutter Traffic Signal Posts
should be at all intersections!

Full Descriptive Literature on request

GEORGE CUTTER COMPANY
SOUTH BEND, IND.

Chicago Detroit New York
Los Angeles San Francisco Seattle

SPECIFY WARREN
Cast Iron Pipe

For Water, Gas, Culverts, Sewers

We specialize in Bell and Spigot and Flanged Special Castings. Also flexible Joint Pipe, Cylinders, Tubes, Milled and Plain Ends—High Pressure Fire Service Pipes.

Warren Foundry & Machine Co.

Sales Offices:
Bowling Green Bldg., New York.
201 Devonshire St., Boston, Mass.
Works: Phillipsburg, N. J.
"Quality and Service Guaranteed"

STEWART SEWER CLEANING MACHINE

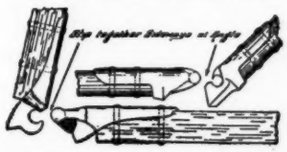
Water Cleaning System if you wish it, or Drag Bucket type.

Also have TURBINE SEWER CLEANING MACHINE at Low Price.

WE WILL PAY FREIGHT AND CHARGE TO BILL.

We Ship Rods for Trial—who else will do this?

We also make a Rod that will float. Also Rods with wheels for conduit work.



SEWER AND CONDUIT RODS

No Deep Shoulder Cut for Couplings—Rods retain full size and strength

Investigate our JUMBO ROD

W. H. STEWART

1614 Locust Street - - ST. LOUIS, MO.
129 George Street - - - BOSTON, MASS.

CANADA FACTORY, WALKERVILLE, ONT.
THEREFORE NO DUTY FOR PURCHASER TO PAY
PACIFIC COAST DELIVERIES MADE FROM SAN FRANCISCO.

Wash., Seattle—Chas. G. Huber, City, award. contr. to constr. 170 ft. 3-sp. Luten design conc. brdg., at Kanasket, at $22,679.

W. Va., Naugatuck—Vincennes Brdg. Co., Vincennes, award. contr. for steel brdg. over Pigeon Crk., at $15,000.

W. Va., Williamson—Corns & Thomas, First Natl. Bank Bldg., Huntington, award. contr. by Mingo Co. Rd. Dist. for bldg. 6 conc. brdgs. on Mate and Ben Crks., at $16,000.

PROSPECTIVE WORK

ROADS AND STREETS.

Ala., Tuscumbia—Colbert Co. Bd. of Commrs. has appropriation of $50,000 for constr. of rdway. approaches to new govt. dam No. 2 at Muschee Shoals. Lauderdale Co. will, it is expected, appropriate $50,000 for approaches from nohth side of river.

Ariz., Phoenix—About 72 miles of rd. planned through Maricopa, Pinal and Gila Cos. Lamar Cobb, State Engr.

Ariz., Douglas — Cochise Co. has voted $1,000,000 bonds for constr. of roads.

Ark., Batesville—Bids may be asked abt. July 1st for grading 80 miles of road, with culverts. Approx. cost, $140,000. Bonds to be sold for one-half cost of constr.; balance to be borne by State Hwy. Comn. and U. S. Govt.

Ark., Lake City—Craighead Co. Comrs. have plans for bldg. 26 mi. bitum. macad. rd.—Lake City to Bay. Est. cost, $363,777. W. H. Fuller, Co. Judge.

Ark., Osceola—Miss. Co. Comrs. have plans by State Hwy. Comn., Little Rock, for 43 miles graded earth road. Approx. cost, $104,700.

Ark., Springdale—Rd. Distr. No. 1 has $15,000 state & fed. aid; Dist. No. 2, $50,000. First named includes 10 mi. of rd., and is to build hwy. from Springdale to Madison Co. line; also from Springdale half way to Fayetteville; Distr. No. 2 includes 43 mi. and will build hwy.—Fayetteville to Winslow; also from Fayetteville east to Madison Co. line. Est. cost of this project, $165,000.

Cal., Los Angeles—$27,000 to be expended in harbor district. Truck hwy. (which has already been graded) will be completed at cost of $15,000; connecting link betw. Redondo and Torrance will be paved, $6,000; rds. across Nigger Slough will be paved at cost of $6,000.

Cal., Sacramento—Dept. of Agriculture has approved Trinity River project. Fed. Bureau has set aside $664,000 for constr. of this hwy. in Trinity & Humboldt Cos., main cross-state hwy., and Klamath River Hwy., connecting Siskiyou County; Humboldt Co. will add $200,000, which assures the extension of Redding-Weaverville lateral to Humboldt Bay.

Cal., San Pedro—$160,000 bonds voted by Imprvt. Dist. No. 7 (San Pedro & Wilmington) for constructg. abt. 4 mi. conc. hwy. connectg. above towns with Harbor City. Rdway will be 22 ft. wide, paved with 6-in. conc., with 5-in. shoulder on each side.

Cal., Weaverville—Forest Bureau and Dept. of Agriculture have set aside $40,000 for constr. of rd. along Trinity River—Gray's Ranch to Burnt Ranch, and a further sum of $10,000 for bldg. suspension brdg. across this river at Hawkins Bar. Department requests that county build rd. from northern approach to Hawkins Bar. brdg. to Hawkins Bar. Cost $1,500.

Colo., Denver—Eight post aid projects, amounting to $556,000, approved by Govt. These are along the inter-mountain military highway.

Colo., Denver—City considering extension of Broadway. Approx. cost $450,000.

Colo., Denver—Secy. of Agriculture has approved expendt. of $19,000 (upon recommendation of Lieut. Col. H. S. Graves, Chief Forester, U. S. Forest Service) on constr. of rd. to Mt. Evans by federal government, in conjunct. with city and county of Denver. Rd. will extend 33 miles—Bergen Park to top of Mt. Evans.

D. C., Washington—Bill introduced by Representative Cooper, of Ohio, providing that U. S. aid States in maint., repair & reconstr. of public rds., which are subjected to extraordinary traffic conditions by war uses. Bill would appropriate $10,000,000.

Idaho, Albion—State Hwy. has agreed to designate road betw. Albion and Marshfield as state hwy., with understanding that Albion Hwy. Dist. will expend $25,000 on it this year.

Idaho, Boise—$340,000 to be expended on north and south state hwy. extending into the panhandle. Money provided for Fourth of July canyon rd. in northern Idaho and Coeur d'Alene hwy. Surveys ordered for several other proposed hwys. State Hwy. Comn. has declared roads in this state to be a necessity for the success of the Government's war program. Necessary funds to put and keep the hwys. in good condition will be forthcoming.

Idaho, Boise—Federal Govt. has requested that preliminary steps be taken to build hwy.—Grangeville to Whitebird. Approx. cost abt. $220,000. Rd. is 21 mi. long. As soon as surveys are approved bids will be asked.

Chicago, Ill.—Plans & specifs., etc., for 5 mi. 18 ft. pavement approved by State Div. Hwys. Improvt. will be made on Chicago, Waukegan & Milwaukee Rd., Cook Co. Alternate bids will be asked on Portland cem. conc. & bitum. conc. on conc. base. Abt. $120,000. B. D. Barker, Co. Bldg., Supt. Hwys.

Ill., Chicago—City soon to ask bids for grading & paving Wabash Ave.—Congress to 12th St.—abt. $85,000. Work involves 15,600 cu. yds. wood block on 6-in. conc. base, granite conc. curbs on cinders and sand or gravel. J. Erickson, City Engr. City will also ask bids, in near future, on abt. 12,000 sq. yds. brick and conc. pavements in alleys. Abt. $35,000.

Ill., Joliet—City contemplates paving Iowa and Mississippi Aves., 3rd Ave., Grant Ave., etc. Est. $65,313; also Ruby St. & Douglas St.

Ill., Springfield—Approx. $9,000,000 available from county bond issues and government appropriations for construction of road betw. Chicago and St. Louis.

Ind., Indianapolis—Marion Co. Council has passed Ord. authorizing issue of $600,000 bonds for three main market hwys. in county.

Ind., So. Bend—$95,000 appropriation recommended for hwy. work as follows: $65,000 on rd. betw. So. Bend and county line; $10,000 on hwy. bet. Osceola & Baugo Crk. brdg. on county line, and $20,000 for constr. of Baugo Crk, bridge.

Ia., Davenport—City considering plan to construct boulevard through Goose Hollow—8th & Harrison to Locust & Division Sts., to connect with Hickory Grove Rd. Three arch bridges will have to be built to carry Gaines, Brown and Warren Sts. over proposed traffic way. Approx. cost of bridges, $70,000.

Ia., Des Moines—Co. Bd. Supvrs. expect to spend $262,000 for various improvements in Polk County. It is planned to grade & gravel Des Moines-Ames Rd. from north to south boundaries of county—abt. 23 mi. Approx. cost $50,000. Considerable pressure has been brought upon Bd. to pave So. W. 9th Ct.—city limits to army post at Fort Des Moines, abt. 2 mi. Est. cost $32,000.

Ia., Iowa City—City considering improvt. of 11 miles of rd. out of city on River to River Rd. Est. cost $100,000.

Md., Baltimore—Chief Engr. J. N. Mackall & former Chf. Engr. Henry G. S. Shirley, of St. Rds. Comn. have submitted estimate for improving Washington Blvd.—$340,000 to $350,000. Engineers think Government should contribute liberally toward cost of the work, as road is being used by heavy trucks to haul materials to Camp Mead and Laurel. Repairs to rd. will call for use of 27,000 tons of stone for conc., 15,000 tons of sand, 30,000 bbls. cement and abt. 8,000 tons of stone for macadamizing.

Md., Baltimore—City is considering widening of St. Paul St. Real Est. Bd. declares this an important improvt., as it would afford direct connect. of north of city with center, the water front & So. Baltimore.

Md., Baltimore—Bonner Road is to be paved. It is also planned to improve Baltimore-Washington Rd. Est. cost $340,000. Jno. C. MacKall, Ch. St. Engr.

Md., Laurel—Road from Camp Harrington at Laurel to Camp Meade at Annapolis, will be constructed by War Dept. State Rds. Comn., Garrett Bldg., Baltimore, will prepare plans and have charge of engineering, etc.

Mich., Pontiac—$200,250 available for road construction this year. No obstacle in way of improvements.

Mich., Saginaw—Retail Merchants' Bureau & Saginaw Bd. of Trade strongly in favor of river route—Saginaw to Midland. first link in 200-mile hwy. from Saginaw to Straits of Mackinaw. Roscommon Co. has issued $75,000 bonds and planning additional bond issue. It is expected that Saginaw will issue bonds at same rate.

Acetylene and electrical welders
Asbestos workers
Blacksmiths
Anglesmiths
Drop-forge men
Flange turners
Furnace men
Boiler makers
Riveters
Reamers
Carpenters
Ship carpenters
Dock builders
Plumbers and pipe fitters
Sheet-metal workers
Coppersmiths
Shipfitters
Structural iron workers
Riveters
Erectors
Bolters up
Other trades
Cementers
Crane men
Chippers and calkers
Electrical workers
Electricians
Wiremen
Crane operators
Foundry workers
Laborers, all kinds
Loftsmen
Template makers
Machinists and machine hands, all sorts
Helpers
Painters

If you possess the right sort of training now is the time to rally around this movement and wear a Badge of Honor. This button, issued by the United States Shipping Board shows that the wearer, through enrollment in the United States Shipyard Volunteers, has placed the welfare of the Nation above all else and stands ready by his labor to help throw across the seas a bridge of ships by which the armies of the United States can pass to do their duty on the fields of France.

Edward N. Hurley, head of the United States Shipping Board, Washington, D. C., is the mouthpiece of Uncle Sam in this call for shipyard volunteers. He has complete information on hand ready to mail you, regarding method of enrollment and other details you may want to know.

Mich., Traverse—Grand Traverse Co. contemplates construction of roads in various townships. Abt. $50,000.

Minn., St. Paul—26 miles of road will be built in Carver County under Fed. aid sys. Est. cost $70,000. Rd. will run across county from Hennepin Co. line to McLeod Co. line on Yellowstone Trail; eighteen miles will be built in Wabasha Co. on hwy. running betw. Wabasha and Rochester. Est. cost $73,000.

Minn., St. Paul—It will be necessary to expend abt. $150,000 to make proposed extension of Robert Street widening into University Ave. This is a vitally needed traffic artery from the West into the downtown district.

Mo., Independence—3 miles brk. paving planned on Van Horn Rd. Est. cost $180,000. Plans also being prepared by Oliver C. Sheley, Jr., Co. Surv., Jackson Co., for rock rd. betw. Sugar Crk. & Cement City —1.25 miles.

Mo., St. Louis—Bill introduced by Alderman Hart for appropriation of $393,073 for opening and widening Washington Ave.—Jefferson to Grand.

Mo., Savannah—$1,000,000 bonds voted by Andrew County for bldg. hard-surfaced roads in county. Lester C. Cottrill, Co. Surv.

Montana—Following counties have reported proopsed road work for 1918: Baker, Fallon County (E. F. Lontz, Clk.), $25,000; Butte, Silver Bow Co. (Sam L. Anderson, Clk.), $40,000; Hardin, Big Horn Co. (R. P. Ross, Clk.), $10,000; Havre, Hill Co. (Jno. H. Devine, Clk.), $120,000; Superior, Mineral Co., contr. wk. to be done by Forest Service (J. D. Dwyer, Clk.), $60,000; Townsend, Breadwater Co. (Wm. G. Ragen, Clk.), $10,000; Virginia City, Madison Co. (D. A. Noble, Clk.), $40,000; Wibaux, Wibaux Co. (L. C. Faltermeyer, Aud.), $40,000.

N. J., Jersey City—$800,000 to $900,000 expenditure being considered for granite blk. paving on Newark Turnpike in Hudson Co. T. J. Wasser, Co. Eng.

N. M., Santa Fe—Expenditures on state hwys. in Grant Co., totaling $57,000, submitted to State Hwy. Comn.: Silver City-Mogollon rd., $23,587; Apache-Tejo rd., $4,320; Borderland rd., $13,000, & Silver City-Lordsburg rd., $13,000; also Silver City-Sherman rd., $6,000; Socorro county's expenditures total $183,550, as follows: Socorro-Datil rd., San Marcial rd., $18,550, Datil Forest Reserve rd., $53,000, $112,000 fed. aid on first named.

N. Y., Little Valley—$49,976 appropriated by State for maint. of highways in Cattaraugus county.

N. Y., New York—Senate has passed Farrenkopf bill authorizing city to bld. boulevard across Jamaica Bay—Woodhaven to Rockaways Peninsula.

N. Y., Rochester—Mullan-Dobson bill passed by legislature. This practically assures the constr. of lake shore boulevard for entire width of county—Manitou beach to Nine Mile Point. Bill provides for the reapportionment of surplus money which now exists in 19 counties. Monroe County's surplus is $260,000. Governor Whitman has intimated he will sign bill.

N. Y., Rochester—City contemplates asph. paving on Bay St. — Portland to Webster Ave. Approx. cost $150,000.

O., Ashland—Plans well under way for prem. improvt. of Lincoln Hwy., from Ashland to Richmond Co. line—abt. 6 miles. Est. cost abt. $30,000 a mile. Total cost abt. $180,000. State aid has been solicited to amt. of $60,000.

O., Chillicothe—$1,000,000 fed. aid to be requested for purpose of improving various roads entering city. Cincinnati to Chillicothe hwy. is among the most important. Appropriations of amt. of $376,000 available for improvt. of this road in Highland Co.

O., Cincinnati—Co. Commrs. contemplate improving Muddy Crk. road—Ebenezer to Devil's Backbone rd. Approx. cost $52,000. Ord. also passed for issuance of $15,500 for purpose of improving Cosby St., Hill Crest Rd., and Pike St.

Cleveland, O.—City plans to expend $360,000 for street improvements as follows: Euclid Ave.—E. 55th to E. 107th St.; Euclid Ave.—Superior to Ontario in downtown sect.; St. Clair Ave.—E. 9th St. to Collinwood; Detroit Ave.—W. 25th to city limits; Lorain Ave.—W. 25th to W. 58th; Clark Ave.—W. 25th to W. 58th; E. 55th St. to E. 105th St.

O., Cleveland—Co. Engr. Stinchcomb has returtned from Washington with authorization to issue $428,000 rd. bonds.

O., Wooster—Wayne County's share of cost of paving Ashland-Wooster Rd. will be $110,500 (6.72 mil); $88,000 for 5 mi. on Wooster-Creston Rd. This road will cost $138,000 of which state will pay $50,000.

Ore., Astoria—Ord. passed by council for immediate improvt. of 7th St. This means that Smith's Point road and Seventh St., only 2 arteries leading to industrial plants on Youngs Bay, will be improved at same time.

Ore., Portland—Bids soon to be asked for paving 82nd and Division Sts.; also Foster Rd. Est. cost, $71,703. Geo. Tazewell, Judge, Multnomah Co.

Pa., Lancaster—Twelve mile hwy.—Lancaster to Maryland line—being considered by Lancaster Co. Comrs. Approx. cost $240,000.

Pa., Pittsburgh—City will widen Water St.—Grant St. to the Point. Two plans being considered; one calls for expenditure of $50,000; the other, $150,000.

R. I., Newport—$500,000 will be expended on reconstruction and new construction of roads. Work will start as soon as possible. Among the roads to be improved are the following: Warren & Bristol Rd., 1.5 mi.; Portsmouth, 2.25 mi.; Tiverton, Skaonnet Point Rd., 1.5 mi. Work on Narragansett Pier Rd. is now going on.

Tenn., Johnson City—City has appropriation of $75,000 to pave additional streets with asph. W. O. Dyer, City Engr.

Tex., Palestine—Bids soon to be asked by Mills Q. Reeves, Co. Judge, Anderson Co., for constr. of rds. in Montalba Rd. Dist., $40,000 available; also for rd. constr. in Blackfoot Rd. Dist., $10,500 available; and in Tennessee Colony Rd. Dist., $60,000 available. Engrs., Hess & Skinner, Dallas, Tex.

Tex., Willis—$100,000 bonds voted for good roads here. Plans call for bldg. roads leading to and from Willis in six different directions; also connectg. link of Exall Hwy.

Va., Petersburg—Concrete rd.—Petersburg to Camp Lee—will be widened from present width of 14 ft. to 20 ft. Est. cost $20,000. Work will be done under government & state appropriations.

Wash., Spokane—City considering expenditure of $194,157 to improve West Spokane St. distr., extending from 1st Ave., S.,

ACME

Manholes, Catch Basins, Inlet Basins, Park Basins (All Styles)

REGULAR AND SPECIAL GRATES OR STRAINERS FOR SEWER PIPE.

BUILDING COLUMNS OF ALL DESCRIPTIONS.

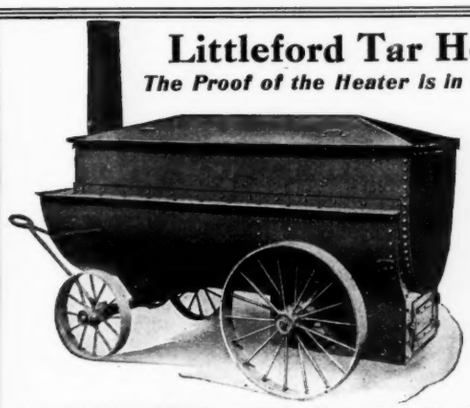
SEND US YOUR SPECIFICATIONS

MADISON FOUNDRY CO.

927 Addison Road, CLEVELAND, OHIO.

Littleford Tar Heaters

The Proof of the Heater is in the Heating



Built in sizes ranging from 50 to 900 gallons.

Especially adapted for road and street construction and maintenance work.

Write for Catalog.

LITTLEFORD BROS., 460 E. Pearl St., Cincinnati, Ohio.

Buy Labor-Saving Machinery

Labor costs more than ever before. Feed is high and going up. Horses were never so valuable. Don't use skilled men and expensive teams to do work that can be done more quickly, more efficiently and more economically by a machine. Now is the time to place your orders if you would make sure of deliveries.

WM. E. DEE COMPANY

30 North La Salle Street. CHICAGO, ILL.

WE MANUFACTURE

D & D Safety Cover

GUARANTEED NOT TO RATTLE OR DISH

Full Line of MANHOLE and CATCH BASIN COVERS of all Kinds.

WRITE FOR OUR PRICES

to East Waterway, by grading, filling, paving with suitable material, etc.

Wash., Olympia—Work will begin at once on paving 6 mi. Olympia-Camp Lewis Rd. State Treasury has bought up the $100,000 bonds, issued for this project; federal aid to amt. of $35,000.

Wis., Milwaukee—Resolution passed by City Council to improve Burleigh St., betw. 35th and Sherman Blvd., which is partly in this city and town of Wauwatosa, with perm. asph. pavement. $21,000 will be appropriated for work.

W. Va., Wayne—About July or August 1st Wayne Co. will ask for bids on rd. construction. Brick on conc. base, $1,000,000 available. A. D. Williams, Engr., Charleston, W. Va.

Wis., Richland Ctr.—Plans under way to build fed. conc. rd. in Rock Co. About 5 mi. 16-ft. plain conc. C. E. Moore, Janesville, Wis., Co. Hwy. Comr.; State Div. Engr., F. M. Balsley, Washington Bldg., Madison, Wis. Approx. cost, $195,000.

Wis., Stevens Point—Plans for bld. federal aid rd. in towns of Dewey & Hull, extending south from Marathon County, have been sent to Washington for approval. Est. cost $24,000. A. E. Bourn, Co. Clk.

Wyo., Cheyenne—State Hwy. Engr. preparing plans for bldg. 8 mi. conc. or bituminous conc. rd—Sheridan to Big Horn. Approx. cost $200,000.

Wyo., Cheyenne—60-mile road will be built this summer from Walcott to Wamsutter through Rawlins. Work will be done under direction of state hwy. commission. Stanley Cobhen, Division Engr.

SEWERAGE AND SEWAGE TREATMENT.

Ariz., Douglas—City considering possibility of laying sewer line from city limits to Camp Harry J. Jones.

Cal., Los Angeles—Bids soon to be asked for one of the largest sewer jobs offered to Los Angeles contractors for some time. Work comprises 28,000 lin. ft. 6 to 20-in. cem. pipe sewers in Glassell Ave., betw. intersect. of San Fernando and Verdugo rds., and York blvd., and portions of side streets from Ave. 30 to Ave. 45. Job will involve considerable trenching, heaviest cut being abt. 30 ft., & considerable portion of it being 10 to 16 ft.

Cal., Porterville—City trustees have authorized City Engr. Fred Pease to prepare plans & estimates for extension of sewers into territory recently annexed by city, including Wallace & Willow Sts., N. 2nd St. and Luther Burbank Addns., requiring several miles of sewers.

Cal., San Diego—State Bd. of Health has ordered piping of sewage at radio station to distant point, or installation of plant for more effective treatment of sewage than is obtained by present septic tank. An Imhoff tank will most likely be built at county hosp. for tubercular patients. State Bd. has ordered adoption of some sys. for treat. of sewage on acct. of prospective increase in number of patients. Filters or sub-irrigation may be added later.

Ct., Bridgeport—Sewer work in Stratford for Hollister Heights sect. will cost $178,000. This does not include disposal works which are to be located on banks of Housatonic river opposite Elm St.

Fla., Miami—City considering bond issue amounting to $65,000 for new sewerage system in Highland Pk., and sewer extensions in city. C. W. Murray, City Engr.

Ia., Des Moines—City contemplates bldg. new southwest sewer sys.—abt. 26 miles in length. Approx. cost $500,000. Fed. authorities have recommended that city provide proper means to insure san. conditions at Camp Dodge.

Mass., Boston—City contemplates bldg. sewerage system. Council passed order for $600,000 appropriation for this project.

Mass., Wellesley—Plans under way to bld. abt. 12,000 ft. sewer as bal. of sewer from here to Metropolitan system, involving 1,300 ft. rock for tunnel; bal. earth trenching & laying 33x36 & 36x40 in. conc. pipe.

Mich., Detroit—City officials investigating offer made by Philadelphia firm to build sewers for city on basis of 10 per cent. profit, city to furnish labor and materials, also pay overhead charges. Bd. of Ests. expected to issue $10,000,000 bonds for sewer construction.

Mich., Detroit—Meetings being held to further plan for bldg. interceptg sewers along river front to carry sewage from Ford, Walkerville and Windsor, Ont. New sys. (temporary) will cost $210,000; Windsor's share, $26,000.

Mich., Grand Rapids—City Mgr. Cummin has submitted estimate to City Comn. for construction of Silver Creek sewer system, at $40,200.

Mich., Hamtramck—Town will construct $100,000 sewer—mile & three-quarters in length. If Govt. does not approve of this expenditure, bond issue of $50,000 to $75,000 will be voted upon.

Mich., Wyandotte—$155,000 bonds voted to improve sewerage sys. C. H. Block, City Clerk.

Minn., Duluth—Bids will be asked soon for constructing storm sewage sys. along Woodlawn Ave., 4th to Austin Sts. Est. cost, $50,000. Plans approved by Bd. Pub. Wks. J. A. Farrell, Commr.

Minn., Minneapolis—Fed. Capital Issues Comm., at Washington, has approved sale of $150,000 bonds for purpose of paying for sewer constr. on trunk line sewers. Sewers will be built on Nicolett Ave., Lynnhurst; on Oak St. and in Linden Hills Distr.

Mont., Great Falls—Both sewer and waterworks systems will be constructed in Scobey, Mont., within the near future. Bonds to amt. of $103,000 voted for the work.

Neb., Omaha—Ord. passed by Council for sale of $400,000 sewer bonds for work to be done this year.

N. J., Hoboken—Resolution introduced by Director Fagen, Dept. of Sts. & Pub. Improvts., providing for purch. of 3¾ acres of land in Rockaway watershed below Boonton Dam, for constr. of sewage disp. plant connected with intercepting sewer at Boonton.

N. Y., Brooklyn—New sewerage plant will be installed at Brooklyn State Hospital. Hospital Comm., Albany, plan to expend abt. $30,000 for this purpose.

N. C., Azalea—War Dept., Washington, will build sewer sys., for $1,500,000 tuberculosis sanatorium. Gude & Co., Gen. Contr., Atlanta, Ga.

O., Canton—City has sold $290,000 bonds for purpose of constructing east and west intercepting sewers (sanitary). W. E. Sarver, City Engr.

O., Springfield—City considering constr. of san. sewer in Wardner Park addn. Plans, specifs., etc., filed with City Mgr., Chas. Ashburner by Chief Engr. M. J. Bahin. Est. cost, $11,455.

Pa., Meadville—City contemplates constr. of sewerage disp. plant. Est. cost, $100,000. B. F. Miller, Jr., City Hall, City Engr.; Chester & Fleming, Union Bk. Bldg., Pittsburgh, Consulting Engrs.

Tex., Fort Worth—No delay anticipated in extending city sewerage sys., to connect with that being installed at Camp Bowie. Est. cost, $75,000. Plans nearing completion. City will lay 8,000 ft. 42 and 42 inch pipe. City Engr., Mr. Von Zuben.

Va., Newport News—Sewers to be built in connection with further development of Hilton—½ mile from Newport News, by U. S. Shipping Bd. Emergency Fleet Corp., (J. Rogers Flannery, Direct. of Housing, 1319 F St., Wash.) Mellon-Stuart Co., Pittsburgh, Gen. Contr.

Va., Winchester—City to expend $25,000 to install sprinkler sewer sys. New system will do away with need of many filtration beds.

W. Va., Charleston—Engineers will soon make survey for sewer system in So. Charleston. Effort will be made to connect sys. with laterals of the government property, according to recent report of Comm. Clark, of Bur. of Yds. & Locks., U. S. Navy.

W. Va., Weston—O. E. Collins, Engr., Philadelphia, Pa., has been retained by St. Bd. Control, Charleston, W. Va., to prepare specifs., etc. for sewage disposal plant at Weston St. Hosp. $45,000 appropriation.

WATER SUPPLY AND PURIFICATION.

Ark., Luxora—$10,000 bonds issued by City for purpose of bldg. water wks. sys.

Cal., Brawley—For purpose of improvg. waterwks. plant, $80,000 bonds have been voted by N. End Water Co. This will include conc. dam for storage purposes.

Cal., Monrovia—$42,500 bonds will be issued for development of water supply. Bonds voted at recent election.

Cal., Reedley—City planning extension of present water supply; also 4-in. two-stage pump & motor will be installed.

Cal., San Francisco—City is considering construction of reservoir in Lincoln Park. Abt. $35,000. M. M. O'Shaughnessy, City Engr.

Cal., San Pedro.—Los Angeles Dept. Pub. Service considering constr. of new and larger reservoir on higher ground than that on which present city reservoir is located.

Ct., Hartford—$600,000 issued by Bd. Co. Comrs. for installation of slow-sand filtration sys., with 20,000,000 gal. capy. C. M. Saville, Pilgard Bldg., Engr.

Ga., Madison—City will soon receive bids for bldg. reservoir with capy. of 750,000 gals. Work will include conc. walls, gravel bottom and conc. walks.

Ill., E. Chicago—Bids soon to be asked

Are You Doing Your Part?

The United States Government has urged business men to relieve the freight situation by employing motor trucks whenever possible, that the railroads may move coal, food and emergency war materials. Every truck so employed is doing a patriotic work of first importance.

Calculations by Govornment officials are that with good highways motor trucks are capable of carrying approximately 200 per cent more freight than the railroads.

Are you using trucks and are you urging the immediate construction of hard-surfaced roads so that these trucks can operate at their greatest efficiency? Put your trucks at work full time. If you haven't a truck, get one; for the more trucks that are put at work the faster the improvement of National highways will follow. The man who puts his dollars into more trucks and better roads is the one whose patriotism counts.

for constr. of filtration plant for E. Chicago & Ind. Harbor Water Co. Approx. cost, $89,000.

Ind., Whiting—Plans being prepared by Pearse & Greeley, Engrs., West Randolph St., Chicago, for bldg. filtr. plant on 119th St., near Centre. Est. cost, abt. $160,000.

Ia., Oskaloosa—May 20 elec. will be held to vote on question of installing municipal waterworks plant at approx. cost of $400,000. T. H. Carlin, City Clk.

La., Gueydan—City contemplates expenditure of $20,000 on water works; $15,000 for light plant and $10,000 on ice plant. Waterworks plans include 6-in. deep well, 60,000-gal. tank, 100-ft. elevat.; pumps, crude oil eng., mains, etc. Engr., J. B. McCraby Co., Atlanta, Ga.

Mass., Sturbridge—Town has petitioned Legislature for permission to appropriate $30,000 for improvement of water supply.

Mass., Westboro—Mass. Comn. on Mental Diseases, State House, Boston, soon to call for bids on bldg. stand pipe and water sys. in Westboro Hosp. Work includes standpipe containing 370,000 gal. on conc. base; 3,580 ft. 4-12 in. c i pipe, etc. Est. abt. $36,840. Kendall, Taylor Co., 93 Fidelity Bldg., Boston, Engrs.

Minn., Fergus Falls—$100,000 bonds voted by City for purpose of bldg. water works. H. J. Collins, Clerk.

Mo., Kans. City—Plans being prepared for City to erect 1-sty. 119x158 ft. pumping sta., brk. & rein. conc. on Nicholson and Monroe Aves. Approx. cost, $1,500,000. B. Lowther, Engr.

Mo., Kans. City—$1,250,000 bonds voted by City for waterworks improvements.

Mont., Terry—Prairie County considering construction of rein.-conc. reservoir—100,000 gal. capy.; also laying of water mains. Abt. $12,000.

N. J., Haledon—Boro Council plans to issue $80,000 bonds for constr. of new reservoir, filter plant, mains, etc., etc. J. E. Stewart, Clerk.

N. J., Jersey City—Ord. introduced in Council, Bayonne, providing for purch. by city of plant, right of way and pipe lines of New York and New Jersey Water Co., for $2,047,000: resolution also introduced and passed directing City Engr. Walter Clarkson, to prepare plans and specifs. for laying under Hackensack River 30-in. pipe lines to connect existing pipes of water company.

N. Y., Buffalo—City soon to ask bids for furnishing 9,600 ft. 36-in. c i pipe to be laid in Parkdale, Rees and Grant Sts.; also Military Rd. Abt. $200,000. G. H. Norton, Engr.

N. Y., Buffalo—City Engr. Norton instructed to prepare plans for new water main for Am. Brass Co. Factory needs 1,800,000 gals. for ten hours' operation. Main will cost betw. $250,000 and $300,000.

N. Y., Kings Park—St. Hospital Comm., Albany, considering bldg. storage reservoir and connections from it to present water system.

N. Y., N. Y. City—Jamaica's Bd. of Est. & Apportionment, considering proposal to extend Catskill Water supply to part of Boro. Plan is to tap the Catskill water supply by running 16-in. main from old Union turnpike through Flushing Ave. to Hillside Ave., abt. 3,000 ft.; from this point have lateral connections and small mains. Est. cost first extens, $17,000.

N. C., Charlotte—W. E. Vest, Supt. Water Wks., considering installation of centrif. pumping units. Specifs. with A. H. Wearn, Comr. Pub. Wks., and with Anderson & Christie, C. E. Est. cost, $175,000.

N. D., Belfield—Louis F. Wolff, 1000 Guardian Life Bldg., St. Paul, preparing plans for constr. of rein. conc. pump house, c. i. pipe mains, rein. conc. reservoir. $35,000. City will ask bids this summer.

O., Canton—City has retained Morris Knowles Co., Inc., Consulting Engrs., Pittsburg, to supervise erec. of large new water pumping station northwest of city, and to supervise devel. of supply of water in this District. Council also adopted report of Finance & Sewer Comms. and authorized erec. of laboratory and other improvts. at sewage disp. plant.

O., Cleveland—City considering bldg. pumping station on E. 49th St., 1 story, 500x600 ft. Approx. cost, $3,000,000. R. Hoffman, City Engr.

O., Ravenna—$50,000 bonds to be sold for purpose of increasing and improving water supply.

Okla., McAlester—City has engaged Burns & McDonnell, Engrs., Kans. City, Mo., to make preliminary survey and cost estimates on constr. of water supply, installation of filtr. sys., and bldg. sewage disposal plant. City also considering $500,000 bond issue.

Okla., Muskogee—City waterworks badly in need of repairs. City considering improvements; centrifugal pump damaged and only one small pump in operation.

Okla., Wewoka—$95,000 bonds voted by City to improve water sys. Benham Engr. Co., Colcord Bldg., Okla. City, Engr.

Tex., Abilene—Plans and specifs. accepted by City for bldg. Elm Crk. dam for water wks. Dam will be 3,000 ft. long at top; 300 ft. wide at base where dam will be 50 ft. high; 500,000 cu. yds. dirt and 2,500 cu. yds. conc.; spillway 1,000 ft. long, 1 mi. n. w. dam center; drain to east and waste water will return to creek 1 mile below dam. Est. cost, $200,000. Horace Roberts, Secy.

Wis., Wausau—Wisconsin Valley Improvement Company will purchase 4,000 acres of land for storage reservoir. Will build dam across mouth of Spirit river at Tomahawk, 16 ft. in height, conc. construction, retaining wall—572,083,000 cu. ft. capy.

BRIDGES AND BUILDINGS.

Ariz., Jerome—Plans being prepared by State Engr. B. M. Atwood, for 210-ft. brdg. over Verde River at Thompson's crossing below Cottonwood. Est cost, with approaches, $40,000. State has appropirated $20,000.

Ark., Ft. Smith—PawPaw, Okla. citizens have voted to raise $50,000 by subscription in Sequoyah County, Okla., to supplement bond issue of Ft. Smith district for bldg. free bridge at foot of Garrison Ave.

Ark., Little Rock—City contemplates bldg. conc. bridge over Ark. River, at foot of Broadway. Bridge will have 5 conc. arches; two highest to be over channel of the river on Little Rock side. Preliminary work will begin in abt. 60 days. Approx. cost, $500,000. Hedrick & Hedrick, Kans. City, are Engrs., with Lund & Hill of Little Rock, associates.

Ark., Little Rock—Pulaski Co. considering constr. of Broadway & Main St. brdgs. Total cost, $1,500,000. Expenditure to be borne as follows: Broadway Brdg. Impvt. Dist., $200,000; Main St. Brdg. Impvt. Dist., $225,000; Little Rock Ry. & Elec. Co., $550,000; balance by County.

Cal., San Rafael—Marin County Supvrs. will build entirely new Belvedere-Tiburon struct. Est. cost, between $25,000 and $35,000. Martin & Sonoma Co. Supvrs. soon to award. contr. for conc. brdg. over San Antonio Crk., on Red Hill Rd.

Can., Bridgeburg Ont.—Canadian-Niagara Brdg. Co., has, through its solicitors, requested Canadian Govt. for permission to build foot, carriage and railway bridge over Niagara River. If application is successful, brdg. will be built betw. Buffalo and Bridgeburg.

Ct., Hartford—Citizens of town of Chaplin in favor of bldg. new wooden brdg. over Natchaug River on state road to Hampton.

D. C., Washington—Among items in Appropriation Bill reported to Senate are the following: $50,000 for replacing fenders on Hwy. brdg. across Potomac River; $8,000,000 for erec. of temp. bldgs. for Govt. use; $500,000 for beginning work on Treasury Annex on N. E. cor. Penn. Ave. and Madison Pl.; $100,000 for completion of War and Navy bldgs. in Henry Park.

Fla., Bradentown—City has voted $45,000 bonds for purpose of constructing portion of bridge across Manatee River, connecting Bradentown and Palmetto; wood construction; length, 1 mile, width 18 ft.; 2-leaf bascule steel draw span with 75 ft. openings. Est. cost, $60,000. Palmetto voted $15,000 bonds for this purpose. Harry Wadham, Comr. Pub. Wks., Bradentown; L. G. Wagner, Commr. Public Wks., Palmetto.

Fla., Miami—City to vote June 26th on $30,000 bonds toward constr. of brdg. over Miami River at Ave. D; also $10,000 for brdg. over Miami River at 12th street.

Ga., Valdosta—Complete plans have been completed for double brdg. over Withlacooche River on National Hwy. Entire structure will be of conc., including flooring, and will be built jointly by State & Co. Hwy. Comn.

Ill., Chicago—Fed. Govt. has authorized City to proceed with constr. of new Franklin-Orleans Street brdg. C. & N. W. Railroad will bear portion of expense.

Ill., Chicago—Frank I. Bennett, Comr. Pub. Wks. reports that the Govt. has released 75 per cent. of steel required in bldg. substruct. of Wells St. brdg., which is to cost abt. $700,000.

Ind., Plymouth—Plans being prepared for constr. of rein. conc. brdg. 80 ft. wide. Est. cost, $45,000.

La., New Orleans—Three large bridges to be built across proposed industrial canal; bascule type; for railway, vehicle and pedestrian traffic. Devereaux O'Reilly, Engr. of Dock Board.

Me., Monticello—Town contemplates bldg. rein. conc. hwy. brdg., girder type, 2 50-ft. spans, 100 ft. long with 20 ft. rdway. Abt. $20,000. P. D. Sargent, Ch. Engr., Augusta.

Me., Yarmouth—P. D. Sargent, State Hwy. Engr. preparing plans for St. Hwy. Comn., Augusta, for bldg. 2 span rein. conc. bridge over Cousins River on St. Hwy., Cumberland Co. Brdg. will be 120 ft. long, 20-ft. rdway.

Miss., Gulfport—Plans under way for construction of bridge across Bay St. Louis. Preliminary survey and cost estimate made by St. Hwy. Dept., Jackson, Miss. This Dept. will supervise construction.

Pa., Harrisburg—Recommendation has been made for new brdg. to replace structure over Tionesta Crk. Forest Co. desires a 3-span, rein.-conc, structure, each span 90-ft. long, rdway. not less than 18 ft. Total est. cost, $45,000.

Books for the Boys "Over There."

The American Library Association is conducting a strenuous campaign for books for soldiers and sailors. This is our part of the effort being made all over the United States to supply books for boys in camps here, on the seas and "Over There." Hundreds of thousands of books are needed every week. As the army increases more books are required. For every man in the service there should be a book in service all the time Only through the mobilization of the volumes lying idle on our shelves can the demand be met.

There is no home in which there are not interesting novels, bought to read on a trip, war books which you will not read again, or interesting books which the family has outgrown. There is a boy in khaki waiting for every one of them.

Why not go over your bookshelves and choose what you can spare?
Send your books to the nearest Public Library and the Librarian will see that the books reach the men in service here and "Over There."

ENGINEERS' AND CONTRACTORS' DIRECTORY

JOHN W. ALVORD :: CHAS. B. BURDICK

Consulting Engineers

Water Supply Sewerage Water Works

HARTFORD BUILDING, CHICAGO, ILLINOIS.

WALTER H. FLOOD

CHEMICAL ENGINEER

PAVING AND ENGINEERING MATERIALS

Tests Inspections Specifications Reports

3725 Langley Avenue CHICAGO

MASON L. BROWN & SON

CIVIL ENGINEERS and LANDSCAPE GARDENERS

820 to 824 Chamber of Commerce, DETROIT, MICH.

Surveys, Plans, Specifications, Estimates, Superintendence, FOR { Electric Railways, Sewerage, Water Supply, Paving, Macadamizing, Parks, Cemeteries, Development of Suburban Properties.

SAMUEL A. GREELEY

64 W. Randolph St. CHICAGO, ILL.

Hydraulic and Sanitary Engineer

Water Supply and Purification. Treatment of Sewage, Garbage and Industrial Waste. Construction, Operation and Valuation.

CHAS. BROSSMAN

CONSULTING ENGINEER

Water Supply. Sewerage and Disposal. Lighting Plants—Supervision of Construction and Reduction in Operating Cost. Appraisals—Expert Testimony.

Merchants Bank Building INDIANAPOLIS, IND.

J. W. HOWARD, Consulting Engineer

PAVEMENTS AND ROADS

Laboratory Analyses and Tests of all Materials

Construction Inspected. 29 Years Experience.

1 Broadway, NEW YORK.

CHICAGO PAVING LABORATORY

LESTER KIRSCHBRAUN, Ch. E., Director

CONSULTING and TESTING ENGINEERS

PAVEMENTS and PAVING MATERIALS

160 N. FIFTH AVE., CHICAGO

Reports, Specifications, Plant, Street and Laboratory Inspection.

SAM. L. JONES, Consulting Engineer

PAVEMENTS and ROADS

Specifications, Estimates and Cost Systems

807 Second Nat'l Bank Bldg. CINCINNATI, OHIO

CITY-WASTES DISPOSAL CO.

(Organized from Staff of Col. Geo. E. Waring, Jr.)

Consulting Engineers. Specialists in Drainage, Sewerage and Sewage Disposal. Preliminary Investigations and Estimates, Surveys, Plans and Supervision. Sanitary Examinations and Reports.

45 Seventh Avenue. NEW YORK.

ALEXANDER POTTER, C. E.

HYDRAULIC ENGINEER AND SANITARY EXPERT

50 Church St., New York City.

Sewerage and Sewage Disposal, Water Supply and Purification, Water and Electric Power.

Valuations of Existing Plants where MUNICIPAL OWNERSHIP is Contemplated — Expert Testimony — Plans and Estimates.

CHARLES E. COLLINS

Mem. Am. Soc. C. E.

CONSULTING ENGINEER

Water Supply, Water Power, Sewerage, Sewage Disposal, Supervision of Construction and Operation, Valuations.

Drexel Building, Philadelphia, Pa.

THE W. J. SHERMAN CO.

Successors to The Riggs & Sherman Co. Established in 1897.

TOLEDO, OHIO.

Reports, Examinations and Appraisals of Existing Improvements made. Surveys, Plans, Specifications, Estimates and Superintendence of New Work. Consultation, Inspection and Tests of Materials.

DOW & SMITH

CHEMICAL ENGINEERS

CONSULTING PAVING ENGINEERS

A. W. DOW, Ph. B. Mem. Amer. Inst. Ch. Engrs. F. P. SMITH, Ph. B. Mem. Amer. Soc. Civil Engrs.

Asphalt, Bitumens, Paving, Hydraulic Cement, Engineering Materials.

131-3 E. 23rd Street NEW YORK CITY

W. S. SHIELDS

CONSULTING ENGINEER

Municipal Improvements. Water Supplies and Water Works Systems. Sewers and Sewage Disposal. Pavements and Roads.

Hartford Building. CHICAGO, ILL.

Testing, Consultation, Bitumens, Paving.
Inspection, Specifications, Asphalts, Road Oils.

ISAAC VAN TRUMP

ENGINEERING CHEMIST

2337 South Paulina Street. CHICAGO, ILL.

SULLIVAN, LONG & HAGERTY

GENERAL CONTRACTORS

Builders of Sewer Systems and Water Works Plants.

Home Office, BESSEMER, ALA.

UVALDE

ASPHALT PAVING COMPANY

1 Broadway, NEW YORK.

CHLORIDE OF LIME

FOR PURIFYING WATER

PENNSYLVANIA SALT MANUFACTURING CO.

115 Chestnut Street, PHILADELPHIA, PA.

Bendigo Sewerage Authority

Engineer-in-Chief's Office:
Town Hall,
Bendigo

MUNICIPAL ENGINEERING,
538 S. Clark St., Chicago,
Illinois, U.S.A.

In MUNICIPAL ENGINEERING of November last, (page 210) you described:- 1. An Odorless Cast Iron Sanitary Catch Basin. 2. A Pipe-pusher that saves Pavements. And in issue of July last (page 19):- 3. Novel Sewer Cleaner. 4. Low Cost Water Main Cleaner.

Would you kindly ask the respective makers (whose names are not mentioned) to let me know the price, weight, and probable freight to Melbourne, Australia, of each article, also name of their Australian agents (if any). Thanking you in anticipation and complimenting you on the "live" character of your magazine.

Yours faithfully,
S. Gordon Moore
Engineer-in-Chief.

You do not find "write-ups" or "puffs" or "reading notices" in Municipal Engineering, but you do find lots of news of interest to our subscribers. Our Information Bureau answers scores of letters (as above) daily.

Municipal Bond Advertising

The success of a sale of state, county or municipal bonds depends entirely upon the publicity given it.

The majority of all municipal issues do not reach the investor directly, but pass through the hands of a dealer who specializes in their purchase and sale.

There are several hundred municipal bond dealers located throughout the country. Many of these bond firms buy a great variety of issues from counties, cities and villages located in the East and West, North and South.

Since a really successful sale will only result from competitive bidding participated in by many different bidders, it is clear that a municipality should advertise its bond offering in a paper specializing in bond news and read by all the dealers interested in this news.

The Bond Buyer, issued daily and weekly, is just such a medium! It never speaks of anything but municipal bonds, and, after twenty-five years of this specilization, it has come to be accepted by legislators and public officials as **"The Authority on Municipal Bonds."**

There is a service rendered by **The Bond Buyer** that every county, city and town treasurer should know about. **If you have bonds to sell,** address

The Bond Buyer

The Authority on Municipal Bonds

25 West Broadway
NEW YORK, N. Y.

PROPOSAL ADVERTISEMENTS

CLASSIFIED ADVERTISEMENTS PAY

If you are seeking employment, have second-hand machinery for sale, want to purchase machinery or supplies, want competent men to fill responsible positions, or have proposals to advertise, an ad. in these columns will put you in touch with responsible parties who can supply your wants.

RATES:

Want Ads. 1½ cents per word.
For Sale Ads. 25 cents per line.
Proposal Ads. 15 cents per line.
Minimum, 50 cents.

Rates on Display Ads. on Application.

Engineering Publishing Co.
INDIANAPOLIS, IND.

Truck Hauling of sand and gravel to let by contract.
NORTHERN CONSTRUCTION CO.,
ELKHART, INDIANA

FOR SALE.

Four Ludlow slice gates, F. O. B. Salt Lake, Utah. Size, 36x48 inches. Complete with lifting stands and operating shafts for a 60-ft. dam, with provisions for extensions. Address N. L. Hall, P. O. Box 607, Salt Lake, Utah.

Bids received until July 31, 1918.

PROPOSAL FOR THE CONSTRUCTION OF FIVE REINFORCED CONCRETE BRIDGES ON THE ROAD FROM SANTIAGO TO MONTE CHRISTI IN THE PROVINCE OF SANTIAGO, DOMINICAN REPUBLIC

DEPARTMENT OF PUBLIC WORKS

Santo Domingo, Dominican Republic

Sealed proposals will be received at the office of the Director General of Public Works, Santo Domingo City, Dominican Republic, until 10 o'clock A. M., July 31st, 1918, for furnishing all materials, plant and labor for the construction of five reinforced concrete bridges located on the road from Santiago to Monte Christi in the province of Santiago, Dominican Republic.

Bridge "A" over the Rio Jacagua, 7.85 Kilometers west of Santiago.

Bridge "B" over the Arroyo Quinigua 10.95 Kms. west of Santiago.

Bridge "C" over the Arroyo Las Lavas 17.89 Kms. west of Santiago.

Bridge "D" over the Arroyo Navarrete 26.28 Kms. west of Santiago.

Bridge "E" over the Rio Ponton 27.50 Kilometers west of Santiago.

The type and length of the bridges are:

Bridge "A" to be a reinforced concrete beam bridge 164′ 0″ long.

Bridge "B" to be a reinforced concrete beam bridge 134′ 0″ long.

Bridge "C" to be a reinforced concrete arch bridge 142′ 0″ long.

Bridge "D" to be a reinforced concrete beam bridge 100′ 0″ long.

Bridge "E" to be a reinforced concrete beam bridge 86′ 6″ long.

All bridges will be 18′ 3″ out to out.

The length of all approaches included in this contract is to be 100′ 0″ more or less and the width will be 23′ 0″ at shoulder of slope.

The plans and specifications may be secured at the office of the Director General of Public Works in Santo Domingo City, Dominican Republic, by making a deposit of Forty Dollars ($40.00) for same, which will be returned after the award of the contract. Plans and specifications have also been forwarded to the Department of Commerce, Washington, D. C.

SANTO DOMINGO, DOMINICAN REPUBLIC, April 22, 1918.

Bids received until June 12, 1918.

REINFORCED CONCRETE BRIDGE.

Sealed proposals will be received by the Controller of Fayette county, Pennsylvania, at his office in the Court House, Uniontown, Pennsylvania, until two o'clock P. M., Wednesday, June 12th, 1918, at which time they will be publicly opened and read in the office of the County Commissioners, for the construction of a double thirty (30) foot span reinforced concrete bridge over Mounts Creek in Connellsville City at Davidson Works.

Plans, proposals and specifications for the above bridge can be secured at the office of the County Road and Bridge Engineer, Court House, Uniontown, Pennsylvania, for the sum of five ($5.00) Dollars pet set.

Each proposal must be accompanied by a certified check drawn on a bank in Pennsylvania equal to ten per cent (10%) of the amount of the proposal.

The right to reject any or all proposals is expressly reserved.

HARRY KISSINGER,
County Controller.

Bids received until June 11, 1918.

ROAD GRADING.

Sealed bids will be received at the office of the County Auditor of Calhoun County, Iowa, until 3:30 o'clock P. M., June 11th, 1918, for the grading to standard section and finished grade and incidental work on the following sections of Road:

Lake City No. 14, located in Sec. 14, Jackson Twp., approx. 5,258.7 cu. yds.; Sherwood Road No. 2, located bet. Secs. 5-6. Lake Creek Twp., approx. 7,236.1 cu. yds.

Plans and specifications for which may be seen at the above office and at the office of the County Engineer. Bids will be opened promptly after the time of receiving the same has closed.

A certified check for five per cent of the bid, made payable to the County Auditor, shall be filed with each bid, which, in case of the bidder, or bidders, receiving the award, should fail to execute a contract and file a bond within ten days after acceptance of his bid, shall be forfeited to the county as liquidated damages.

All bids must be on the regular form furnished by the county, sealed and marked plainly. Any changes made in this form or any additions thereto may cause the rejection of the bid. No bid will be considered which contains a clause in which the contractor reserves the right to accept or refuse a contract awarded him by the Board.

The successful bidder will be required to furnish bond for fifty per cent of the amount of contract, issued by responsible surety, approved by the Board, and drawn to protect the county and any subcontractor.

The county reserves the right to waive defects and to reject any or all bids.

Dated this 6th day of May, 1918.

R. B. DIXON,
County Auditor.
W. E. McCLURE,
County Engineer.

MISCELLANEOUS WANTS

WANTED.

To buy a small iron and wood-working plant, preferably making farm machinery, in small town, with plenty of land for expansion. Address Box 1, Municipal Engineering, 538 S. Clark St., Chicago.

BUSINESS OPPORTUNITY.

Established concern, equipped for building construction and road building, whose active partner has been drafted, will sell reasonable half interest to competent party familiar in above lines. Location, Western Pennsylvania. Address Engineering Publishing Co., 538 S. Clark St., Chicago.

"Return Loads" Bureau

Encourage Motor Truck Owners (within a radius of 200 miles of your city) to haul freight to and from your city, by establishing a ***"Return Loads" Bureau*** at once! Tell him where he can load up so as to return home under a full load. Your commercial organizations should demand that shipments within the specified territory be made by motor trucks over the highways instead of by rail.

The adoption and successful operation of "Return Loads" Bureaus will meet with the approval of shippers and consignees.

BUYERS' GUIDE

Armor Plates.
R. D. Baker Co.
Truscon Steel Co.

Asphalt.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
Warren Bros. Co.

Asphalt Floors.
Warren Bros. Co.

Asphalt Machinery.
Alger Supply Co.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The

Asphalt Plants.
East Iron & Machine Co., The
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Asphalt Surface Heaters.
Alger Supply Co.

Asphalt Tools.
Alger Supply Co.
Warren Bros. Co.

Asphalt Tool Wagons.
Alger Supply Co.

Auto Fire Apparatus.
Garford Co., The
General Motors Truck Co.
Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Pierce-Arrow Motor Car Co.
G. A. Schacht Motor Truck Co.
Service Motor Truck Co.
Signal Motor Truck Co.
J. C. Wilson Co.

Automobiles.
International Motor Co.
Kissel Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Pawling and Harnischfeger.

Bar Benders.
Koehring Machine Co.

Bar Cutters.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
Barrett Co., The
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros. Co.

Blasting Powder.
E. I. DuPont De Nemours & Co.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling and Harnischfeger

Buckets, Dumping.
Pawling and Harnischfeger

Building Stone.
Ohio Quarries Co., The

Calculators.
Kolesch & Co.

Carriers.
Mathews Gravity Carrier Co.

Car Unloaders.
Heltzel Steel Form & Iron Co.
Carts, Street Cleaners.
Holzbog & Bro., Geo. H.

Castings.
American Cast Iron Pipe Co.
Warren Foundry & Machine Co.

Cast Iron Pipe.
American Cast Iron Pipe Co.
Warren Foundry & Machine Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement.
Atlas Portland Cement Co.
The Barrett Co.

Cement Testing.
Hunt & Co., R. W.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Chemical Tests.
Hunt Co., R. W.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.

Concrete Mixers.
Koehring Machine Co.
Pneumatic Concrete Machinery Co.

Concrete Placing Machinery.
Pneumatic Concrete Machinery Co.

Concrete, Reinforcement.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
Brossmann, Chas.
City Wastes Disposal Co.
Collins, Charles E.
Dow & Smith.
Samuel A. Greeley.
Howard, J. W.
Jones, Sam L.
Kirschbraun, Lester.
Potter, Alexander
Sherman, The W. J. Co.
Shields, W. S.
Van Trump, Isaac

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty
Warren Bros. Co.

Contractors' Tools and Machinery.
Alger Supply Co.
Austin-Western Co., Ltd., The
Holzbog & Bro., Geo. H.
Littleford Bros.

Contractors' Wagons.
Austin-Western Co., Ltd., The
Holzbog & Bro., Geo. H.

Conveying Machinery.
Mathews Gravity Carrier Co.
Pawling and Harnischfeger.
Pneumatic Concrete Machinery Co.

Cranes and Hoists.
Heltzel Steel Form & Iron Co.
Pawling and Harnischfeger

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Jennison-Wright Co.
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co., The

Crushed Stone.
Cleveland Stone Co., The
Ohio Quarries Co.

Culvert Forms.
Storms Manufacturing Co.

Culvert Molds.
Austin-Western Co., Ltd., The

Culvert Pipe, Cast Iron.
American Cast Iron Pipe Co.
Warren Foundry & Machine Co.

Culvert Pipe, Vitrified.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Curbing, Sandstone.
Cleveland Stone Co., The
Ohio Quarries Co., The

Drain Tile.
Dee Clay Mfg. Co., W. E.
Rosing, A. S.

Dryers.
Cummer & Son Co., The F. D.

Dump Cars.
Austin-Western Road Machinery Co., The

Dump Carts.
Holzbog & Bro., Geo. H.

Dump Wagons.
Austin-Western Road Machinery Co., The
Holzbog & Bro., Geo. H.

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)

Dynamite.
E. I. DuPont De Nemours & Co.

Edge Protector.
Truscon Steel Co.

Elevators (Automatic Brick).
Mathews Gravity Carrier C.o

Engines.
Wisconsin Motor Mfg. Co.

Engineering Instruments.
Lufkin Rule Co., The

Excavating Machinery.
Koehring Machine Co.
Pawling and Harnischfeger.

Expansion Joints.
Pioneer Asphalt Co.

Expansion Joint Compound.
The Barrett Co.
Pioneer Asphalt Co.
Rosing, A. S.
Truscon Steel Co.

Explosives.
E. I. DuPont, De Nemours & Co.

Fillers (Paving Joint).
The Barrett Co.
Pioneer Asphalt Co.

Financial News.
The Bond Buyer.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Fireproofing.
Rosing, A. S.

Flooring (Bridges).
Jennison-Wright Co.

Flooring (Factory).
Jennison-Wright Co.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.
McNutt, Lewis

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Foundations.
Heltzel Steel Form and Iron Co.

Garbage Disposal Plants.
City Wastes Disposal Co.

Gas Pipe.
American Cast Iron Pipe Co.
Warren Foundry & Machine Co.

Gasoline and Kerosene Pumping Engines.
Wisconsin Motor Mfg. Co.

Gas Pipe.
American Cast Iron Pipe Co.

Graders.
Austin-Western Road Machinery Co., The

Graders, Elevating.
Koehring Machine Co.

Graders, Turbine.
Koehring Machine Co.

Heaters (Rock and Sand).
Littleford Bros.

Heating Wagons (Oil and Tar).
Littleford Bros.

First "Merriman" Plant
(built in 1905)
Still in Operation

Read what its owner says after using the Merriman Plant for 10 years! The recommendations of Mr. Andrews are verified by his purchase of a second plant.

The Merriman Steam Melting Plants are built as one car; Road Asphalt and Stationary Plants.

East Iron & Machine Co.
LIMA, OHIO.

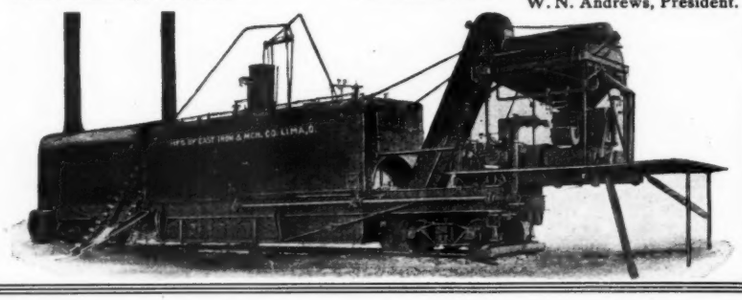
Write for a list of users and ask them about the Merriman

Hamilton, Ohio, December 19, 1916.

EAST IRON & MACHINE CO., Lima, Ohio.

Gentlemen: In reply to your letter of December 16, 1916, asking what our experience has been with the "Merriman" one-car asphalt plant, we have had a "Merriman" one-car plant in use for twelve years and during that time it has turned out over 1,500,000 square yards of binder and top ready to lay. Its best asset is that it will run six days in a week. We have owned two "Merriman" plants since 1909, and they turn out from two to three hundred thousand square yards of material every season.

THE ANDREWS ASPHALT PAVING CO.,
W. N. Andrews, President.



MURPHYSBORO PAVING BRICK COMPANY

Equal to the Best

"EGYPTIAN" BLOCK

Surpassed by None

MURPHYSBORO, ILLS.

PROMPT DELIVERIES. LET US QUOTE YOU PRICES.

M. J. BANNON, Pres. & Gen. Mgr. P. BANNON, Jr., V. P. & Treas.

P. BANNON PIPE CO.

ESTABLISHED 1852. INCORPORATED

Manufacturers of

Bannon's Patent Lidded Pipe for Steam Conduits
Sewer and Culvert Pipe
Wall Coping **Fire Brick**
Flue Lining **Fire Clay**
Grate Tile **Chimney Tops**
Drain Tile

Offices: 528 West Jefferson Street

Works: 13th and Breckenridge Sts. **Louisville, Ky.**

Sewer Pipe
Steam Conduits
Fire Brick
Book Tile

ASTRID ROSING INC.

Harris Trust Bldg. CHICAGO.

American Cast Iron Pipe Company

MANUFACTURERS OF

BIRMINGHAM, ALA.

SALES OFFICES:

Birmingham, Ala.	Box 908.
Columbus, Ohio	607 New Hayden Building.
Minneapolis, Minn.	712 Plymouth Building.
New York City	No. 1 Broadway.
Chicago, Ill.	512 First National Bank Building.
Dallas, Texas	1217 Praetorian Building.
Kansas City, Mo.	716 Scarritt Building.
San Francisco, Cal.	711 Balboa Building.

Holzbog Sanitary Garbage Carts are smell-tight and can't leak.

Send for Catalog if interested.

GEO. H. HOLZBOG & BRO.
Manufacturers of Sanitary Carts, Ambulances and Litters
JEFFERSONVILLE, IND.

BEST EXTENSIBLE TRENCHING BRACE MADE

KALAMAZOO F'DRY & MACHINE CO. MICHIGAN

594 EAST MAIN STREET.

SLUICE GATES
Shear, Flap and Butterfly Valves
FLEXIBLE JOINTS
COLDWELL-WILCOX CO.

South Water Street NEWBURGH, N. Y.

BUYERS' GUIDE

Hex Block.
Jennison-Wright Co.

Hoists (Concrete, Gasoline and Hand).
Pawling and Harnischfeger.

Hoists, Electric.
Pawling and Harnischfeger.

Hoists, Steam.
Lewis-Hall Iron Works.

Hot Mixers.
Koehring Machine Co.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Installing Device.
R. D. Baker Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
Pioneer Asphalt Co.

Kettles (Portable).
Cummer & Son Co., The F. D.

Kreolite Lug Block.
Jennison-Wright Co.

Laboratory.
Chicago Testing Laboratory.
Kirschbraun, Lester.

Lamp Posts.
Cutter Co., Geo.

Landscape Engineers.
Brown, Mason L.

Lists.
R. L. Polk & Co.

Loaders, Wagon.
Mathews Gravity Carrier Co.

Locomotives.
Bell Locomotive Works, Inc.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
Pioneer Asphalt Co.

Meter Boxes.
Ford Meter Box Co., The

Meter Testers.
Ford Meter Box Co., The

Mixers, Asphalt.
Cummer & Sons Co., The F. D.
Koehring Machine Co.

Mixers, Concrete.
Koehring Machine Co.
Pneumatic Concrete Machinery Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motors.
Wisconsin Motor Mfg. Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Garford Motor Truck Co.
General Motors Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Pierce-Arrow Motor Car Co.
G. A. Schacht Motor Truck Co.
Service Motor Truck Co.
Signal Motor Truck Co.
J. C. Wilson Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Garford Motor Truck Co., The
General Motors Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Pierce-Arrow Motor Car Co.
G. A. Schacht Motor Truck Co.
Service Motor Truck Co.
Signal Motor Truck Co.
J. C. Wilson Co.

Motor Truck Ambulances and Patrols.
Acme Motor Truck Co.
Garford Motor Truck Co., The
General Motors Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Pierce-Arrow Motor Car Co.
G. A. Schacht Motor Truck Co.
Service Motor Truck Co.
Signal Motor Truck Co.
J. C. Wilson Co.

Motor Truck Flushers and Sprinklers.
Acme Motor Truck Co.
Garford Motor Truck Co., The
General Motors Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Pierce-Arrow Motor Car Co.
G. A. Schacht Motor Truck Co.
Service Motor Truck Co.
Signal Motor Truck Co.
J. C. Wilson.

Motor Truck Oilers.
Acme Motor Truck Co.
Garford Motor Truck Co., The
General Motors Truck Co.
The Gramm-Bernstein Motor Truck Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
G. A. Schacht Motor Truck Co.
Service Motor Truck Co.
Signal Motor Truck Co.
J. C. Wilson Co.

Municipal Castings.
Dee Co., Wm. E.

Natco.
National Fire Proofing Co.

Packing.
Pioneer Asphalt Co.

Paints.
The Barrett Co.
Pioneer Asphalt Co.
Truscon Steel Co.

Paints, Asphalt.
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Dunn Wire-Cut Lug Brick Co., The
Medal Paving Brick Co.
Murphysboro Paving Brick Co.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
Pioneer Asphalt Co.
Truscon Steel Co.

Paving Joint Filler.
Pioneer Asphalt Co.

Paving Machines.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Koehring Machine Co.
Warren Bros. Co.

Paving Plants (Asphalt).
Cummer & Son Co., The F. D.
East Iron & Machine Co.
Koehring Machine Co.
Warren Bros. Co.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.

Pipe Manufacturers.
American Cast Iron Pipe Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Koehring Machine Co.
Warren Bros. Co.

Powder.
DuPont, DeNemours & Co., E. I.

Pumps (Contractors).
Holzbog & Bro., Geo. H.

Reinforcing For Pavements.
Truscon Steel Co.

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The

Road Machinery.
Austin-Western Road Machinery Co., The
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Koehring Machine Co.
Warren Bros. Co.

Road Oils and Preservatives.
The Barrett Co.
DuPont Chemical Co.
Standard Oil Co. (Indiana)

Road Rollers.
Austin-Western Road Machinery Co., The

Road Scarifiers.
Austin-Western Road Machinery Co., The

Rock Crushers.
Austin-Western Road Machinery Co., The

Rock and Sand Heaters.
East Iron & Machine Co., The

Roof Coating.
DuPont Chemical Co.

Roofing Material.
The Barrett Co.
DuPont Chemical Co.
Pioneer Asphalt Co.
Warren Bros.

Sand.
Rosing, A. S.

Sand Dryers.
Cummer & Son Co., The F. D.

Sandstone.
Cleveland Stone Co.

Sanitary Carts.
Holzbog & Bro., Geo. H.

Scarifiers.
Austin-Western Road Machinery Co., The

Scrapers, Drag Line.
Pawling and Harnischfeger.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co.

Sewage Disposal.
City Wastes Disposal Co.

Sewage Pumps.
Holzbog & Bro., Geo. H.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.

Sewer Castings.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Bannon Sewer Pipe Co., P.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.
McNutt, Lewis.
Rosing, A. S.

Sewer Rods.
Stewart, W. H.

Sidewalks (Stone).
Cleveland Stone Co.

Sign Posts.
Cutter Co., Geo.

WM. E. DEE CLAY MFG. CO.

Proprietors of MECCA CLAY WORKS

MANUFACTURERS OF

STANDARD AND DOUBLE STRENGTH

Sewer Pipe, Drain Tile, Culvert Pipe, Well Tubing, Flue Lining, Wall Coping and Fire Brick.

WORKS { Mecca, Parke County, Ind., on C. & E. I. R. R.
Newport, Vermillion County, Ind., on C. & E. I. R. R.

Chicago Office, 30 N. LaSalle St.

THE CUMMER ROAD ASPHALT PLANT

Three Sizes. Three Units. Capacity 750, 1250 and 1800 Square Yards 2-inch Top or Macadam Daily

THE CUMMER ONE-CAR ASPHALT PLANT

Capacity 2000 Square Yards 2-inch Top or Macadam Daily

THE F. D. CUMMER & SON COMPANY, CLEVELAND, OHIO

Plants in Stock Can Show Them in Operation

New Automatic Cement Tester

Grand Prize Panama-Pacific International Exposition, 1915.

Manufacturers of Cement, Concrete, Brick and Road Material Testing Machines and All Auxiliary Laboratory Apparatus

Tinius Olsen Testing Machine Co.

500 North Twelfth Street PHILADELPHIA, PA.

SEWER PIPE

Segment Sewer Block, Drain Tile, Hollow Building Block, Flue Lining, Wall Coping, Etc.

LEWIS McNUTT

28 South Walnut St. BRAZIL, INDIANA.

Our Special Feature is anything in the Clay Goods Line in mixed or straight cars.

Clay Products

SEWER PIPE OF QUALITY

Made of a SUPERIOR QUALITY of FIRE CLAY in the Finest Plant in the West.

The pipe that WON THE TEST for crushing strength before the Louisville Sewer Commission, showing an average CRUSHING STRENGTH OF 43 PER CENT HIGHER than competitors' samples. Just a little better than the rest. Write us today for particulars.

CANNELTON SEWER PIPE CO. . . Cannelton, Ind.

Buy Your Lists Made to Order

From our Card File of over 60,000 Names of CONTRACTORS.

We can compile any of the following classes:

General Construction Companies, Cement and Concrete, Paving, Road and Grading, Excavating, Sewers, Bridges and Culverts, Dredging, Public Works, Tunnels, Piling, etc., R. R. and Elec. Ry., Grain Elevators, Waterworks, Mfrs. Cement Products, Sand and Gravel Pits, Crushed Stone, Quarries.

This information we correct daily from various sources of information. Write us your requirements.

Our Catalog of Mailing Lists free.

R. L. POLK & CO.,

Mailing Lists, Addressing, Mailing. CHICAGO, ILLINOIS.

BUYERS' GUIDE

Sluice Gates.
Coldwell-Wilcox Co.

Sprinklers.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Curbing.
Cleveland Stone Co.

Stone Flagging.
Cleveland Stone Co.

Street Cleaners' Carts.
Holzbog & Bro., Geo. H.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Crossings.
Cleveland Stone Co.

Street Flushers (Horse Drawn).
Austin-Western Road Machinery Co.

Street Lighting.
Cutter Co., Geo.

Street Sprinklers (Horse Drawn).
Austin-Western Co., Ltd., The

Structural Steel.
Lewis-Hall Iron Works.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin-Western Road Machinery Co., The

Tamping Machines.
Pawling and Harnischfeger.

Tar and Pitch.
The Barrett Co.
DuPont Chemical Co.

Tar Heaters.
Alger Supply Co.
Littleford Bros.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
Howard, J. W.
Kirschbraun, Lester.
Van Trump, Isaac.

Testing Laboratories.
Howard, J. W.
Lester Kirschbraun.
Tinius Olsen Testing Machine Co.

Traction Engines.
Austin-Western Road Machinery Co., The

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

Trailers.
Warner Mfg. Co.

Trench Braces.
Kalamazoo Fdy. & Mach. Co.

Trench Machinery.
Holzbog & Bro., Geo. H.
Kalamazoo Fdy. & Machine Co.
Pawling and Harnischfeger.

Trucks (Motor).
Acme Motor Truck Co.
Duplex Truck Co.
Garford Motor Truck Co., The
General Motors Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Pierce-Arrow Motor Car Co.
G. A. Schacht Motor Truck Co.
Service Motor Truck Co.
Signal Motor Truck Co.
J. C. Wilson Co.

Valves.
Coldwell-Wilcox Co.

Wall Coping.
Cannelton Sewer Pipe Co.

Warrenite.
Warren Bros. Co.

Water Pipe.
American Cast Iron Pipe Co.
Warren Foundry & Machine Co.

Waterproofing.
Barrett Co., The
Pioneer Asphalt Co.
Truscon Steel Co.

Water Purification.
Pennsylvania Salt Mfg. Co.

Water Works Supplies and Equipment.
American Cast Iron Pipe Co.
Alger Supply Co.
Coldwell-Wilcox Co.
Pennsylvania Salt Mfg. Co.

Windows (Steel).
Truscon Steel Co.

Wire-Cut Lug Brick.
Dunn Wire-Cut Lug Brick Co.
Medal Paving Brick Co.
Murphysboro Paving Brick Co.
Springfield Paving Brick Co.

Wood Block (Creosoted).
Barrett Co., The
Jennison-Wright Co.
Republic Creosoting Co.

Wood Preservatives.
Barrett Co., The
DuPont Chemical Co.
Jennison-Wright Co.
Pioneer Asphalt Co.
Republic Creosoting Co.

Isn't Professor Linn Right?

If you think he is, write today to your Congressman and Senator and tell them so.

Just before adjournment last September, Congress hurriedly adopted the Zone System for second-class postage rates. It is a bad law, and there is still time to change it since it does not go into effect until July 1.

One of the clearest presentations of the folly of curbing our great national magazines comes from the pen of Professor J. W. Linn, of the University of Chicago—a man of knowledge and vision, who sees our country as a whole, reading and thinking and feeling as one people. Read what Prof. Linn says:

If the proposed Zone System of postal rates should be adopted, the result would be the extermination of a very large number of magazines, and as far as the rest are concerned, a large increase in price to the subscriber. Many of these newspapers and magazines have a definite, even what might be called a formal, educational influence—particularly the magazines. They are constantly used in our schools and colleges all over the country as text books—used in courses in literature, in engineering, in history, in civics, in science. Hundreds of thousands of copies weekly or monthly are so employed. They have taken a recognized place in modern education.

You say these newspapers and magazines would not be destroyed by these proposed new laws? You know what would happen—you know that the prices to subscribers would rise, and circulation would narrow—and just who would lose out? You shut them out from the freest possible circulation of ideas, just at the time when that freest possible circulation is most essential. I say as a college teacher, a man who has been in the educational profession almost a generation, that in my judgment you could hardly stab nearer the heart of the nation than by stabbing at the widest possible circulation of newspapers and magazines; and yet that is exactly where this increase in second-class postal rates, this Zone System, is directing the knife.

INDEX TO ADVERTISEMENTS

	Page
Acme Motor Truck Co., Cadillac, Mich	22
Alger Supply Co., Chicago, Ill	7
Alvord, John W., & Charles B. Burdick, Chicago, Ill	40
American Cast Iron Pipe Co., Birmingham, Ala	44
American Telephone and Telegraph Co., New York, N. Y.	
Atlas Portland Cement Co., New York, N. Y	33
Austin Manufacturing Co., Chicago, Ill	4
Baker Company, R. D., Detroit, Mich	6
Bannon Pipe Co., P., Louisville, Ky	44
Barrett Co., The, New York, N. Y	27
Bell Locomotive Works, Inc., New York, N. Y	30
Bond Buyer, The, New York, N. Y	41
Brossman, Chas., Indianapolis, Ind	40
Brown, Mason L., & Son, Detroit, Mich	40
Buyers' Guide	43, 45, 47
Cannelton Sewer Pipe Co., Cannelton, Ind	46
Chicago Paving Laboratory, Chicago, Ill	40
City Wastes Disposal Co., New York, N. Y	40
Cleveland Stone Co., The, Cleveland, O	35
Coldwell-Wilcox Co., Newburgh, N. Y	44
Collins, Charles E., Philadelphia, Pa	40
Cummer & Son Co., The F. D., Cleveland, O	46
Cutter Co., Geo., South Bend, Ind	35
Dee Clay Mfg. Co., W. E., Chicago, Ill	46
Dee, Wm. E., Co., Chicago, Ill	37
Dow & Smith, New York, N. Y	40
Dunn Wire-Cut Lug Brick Co., Conneaut, O	10
Duplex Truck Co., Lansing, Mich	24
DuPont DeNemours & Co., Wilmington, Del	31
East Iron and Machine Co., The, Lima, O	44
Engineers and Contractors	40-41
Federal Motor Truck Co., Detroit, Mich	25
Flood, Walter H., Chicago, Ill	40
Ford Meter Box Co., Wabash, Ind	7
Garford Motor Truck Co., Lima, O	13
General Motors Truck Co., Pontiac, Mich	14
Gramm-Bernstein Motor Truck Co., Lima, O	18
Greeley, Samuel A., Chicago, Ill	40
Heltzel Steel Form and Iron Co., Warren, O	8
Highway Economist	9-10
Holzbog & Bro., Geo. H., Jeffersonville, Ind	44
Howard, J. W., New York, N. Y	40
International Motor Co., New York, N. Y	12
Jennison-Wright Co., Toledo, O	front cover
Jones, Sam L., Cincinnati, O	40
Kalamazoo Foundry and Machine Co., Kalamazoo, Mich	44
Kissel Motor Car Co., Hartford, Wis	23
Koehring Machine Co	
Kolesch & Co., New York, N. Y	28
Lewis-Hall Iron Works, Detroit, Mich	26
Littleford Bros., Cincinnati, O	37
Lufkin Rule Co., The, Saginaw, Mich	32
Madison Foundry Co., Cleveland, O	37
Mathews Gravity Carrier Co., Ellwood City, Pa	31
McNutt, Lewis; Brazil, Ind	46
Medal Paving Brick Co., Cleveland, O	9
Motor Truck Section	11-26
Murphysboro Paving Brick Co., Murphysboro, Ill	44
Olsen Testing Machine Co., Philadelphia, Pa	46
Pawling & Harnischfeger Co., Milwaukee, Wis	6
Pennsylvania Salt Manufacturing Co., Philadelphia, Pa	41
Pierce-Arrow Motor Car Co	20, 21
Pioneer Asphalt Co., Lawrenceville, Ill	33
Pneumatic Concrete Machinery Co., New York, N. Y	33
Polk, R. L., & Co., Chicago, Ill	46
Potter, Alexander, New York, N. Y	40
Proposal Advertisements	42
Republic Creosoting Co., Indianapolis, Ind	5
Rosing, A. S., Chicago, Ill	44
Service Motor Truck Co., Wabash, Ind	16
Schacht Motor Truck Co., Cincinnati, O	inside front cover
Sherman, The W. J., Co., Toledo, O	40
Shields, W. S., Chicago, Ill	40
Signal Motor Truck Co., Detroit, Mich	inside back cover
Springfield Paving Brick Co., Springfield, Ill	9
Standard Oil Co. (Indiana), Chicago, Ill	29
Stewart, W. H., St. Louis, Mo	35
Storms Manufacturing Co., Chicago, Ill	33
Sullivan, Long & Hagerty, Bessemer, Ala	41
Sullivan, Long & Hagerty, Bessemer, Ala	41
Truscon Steel Co., Youngstown, O	8
Uvalde Asphalt Paving Co., New York, N. Y	41
Van Trump, Isaac, Chicago, Ill	4
Warner Manufacturing Co., Beloit, Wis	2
Warren Brothers Co., Boston, Mass	
Warren Foundry and Machine Co., New York, N. Y	35
Wilson Co., J. C., Detroit, Mich	back cover
Wisconsin Motor Mfg. Co., Milwaukee, Wis	19